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Telegraphic Address: "Zacatecas, High Wycombe."
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The Institute of Vitreous Enamellers
The Welsh Engineers' and Founders' Association
The Foundry Trades' Equipment and Supplies Association

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Foundry Technical Institute, Meek's Road, Falkirk
Telephone: 332

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Use and Abuse of Standards

American engineers recently held a meeting at Cleveland, Ohio, to discuss the use and abuse of standards, and under other circumstances we would advocate a similar conference being called in this country, because, despite years of patient endeavour, the implications of standardisation are still but imperfectly understood. Primarily, standards divide themselves into two main categories—(1) dimensional, and (2) materials—though both features may appear in the same specification. The repercussions from "dimensional" standardisation are (1) reduction in manufacturing costs; (2) interchangeability of components; and (3) politico-economical expansion, whilst on the "materials" side the benefits industry derives include the following:—(1) Initial research prior to the act of standardising; (2) the provision of a limited number of materials conforming to prescribed acceptance tests; (3) the simplification of the designers' problems, and (4) a reduction in manufacturing problems.

It might be thought that there was little chance of the abuse of the standards, but it does exist, due mainly to misconceptions. It was rightly stressed at the American meeting that if only a fraction of the energy and foresight was put into publicity for standards as was bestowed upon their actual creation, abuses would be minimised. The worst abuse to our mind results from the placing by the public utility services of their buying in the hands of a man who at all costs is determined "to cover himself." This type of individual, when requested to buy a quantity of material, first consults the B.S.I. list of standards, and, finding a numbered specification, promptly asks as many firms as possible to quote him for a quantity of goods to satisfy its clauses. It often happens that two or three quite different industries compete in the supply of an article, but not all of them may have prepared a standard, in which case they receive an inquiry for a material made by a quite separate industry. Thus iron foundries have been asked to furnish reinforced-concrete lamp standards. The implication of this is that, because one industry has standardised, then that industry becomes the sole source of supply—an obvious abuse of the general system. Again, private specifications or the mere instructions on a blue print are quite sufficient for the unenterprising buyer to prevent the potentialities of competing materials being examined. This, no doubt, is why the Ministry of Supply recently issued the pamphlet on "Alternative Building Supplies in Wartime." Ironfounders would do well to press the claims of high-duty iron as a substitute, for in some cases it is solely the "covering himself" attitude of an official mind which often prevents its economic utilisation.

A second abuse originates from the mind of the crafty sales manager, who essays to impress upon the minds of potential buyers that his competitors supply material paralleling the minimum results as set out in the acceptance tests of the appropriate specification, whilst his own goods yield figures from 20 to 25 per cent. higher than are specified. There is nothing particularly clever in this, as all material must exceed the tests specified by some percentage, and, moreover, some of the most important clauses are not controlled by the citation of figures.

The final abuse, of course, is the selection of the wrong standard by the buyer, who, realising too late its unsuitability, blames the supplier. Obviously, the existence of a specification is no excuse for a lack of co-operation between contracting parties.

There is a third category—the chemical standard—which is analogous to those of the dimensional type. By their use, every honest chemist has a yardstick by which he can measure the comparative accuracy of his own determinations.

Standards have increased both in volume and importance since 1914; a very large number of wartime additions are being made and are contributing very materially to the successful production of armaments. Intelligently utilised they can be of equal value when peace is restored.

Institute of British Foundrymen

PLANS FOR GENERAL MEETING

At a meeting of the Council of the Institute of British Foundrymen, held recently, it was decided that, if possible, a one-day annual general meeting of the Institute should be held at some convenient centre next July. This meeting will provide the opportunity of carrying out the routine business of such a meeting, and in addition it is hoped to hold a technical session, when approximately five Papers will be presented for discussion.

Full details of Papers are, of course, not yet available, but it is possible to say that an Exchange Paper from the American Foundrymen's Association will be presented; this Paper will be on synthetic sand control, and the author will be Mr. Norman Dunbeck, of the Eastern Clay Products, Inc. A Paper on non-ferrous foundry practice will be presented by Mr. F. Hudson and arrangements are now being made to obtain other Papers. Should circumstances dictate the cancellation of this meeting, the Papers will be circulated to all members of the Institute during July.

Papers for Winter Session

The Council of the Institute also gave consideration to the difficulties which some Branches were having in arranging syllabuses for their winter meetings, and they also bore in mind the position of many members, who, for various reasons, were unable to attend such Branch meetings as were arranged. In order to maintain contact with such members and to help the Branches, it was decided to arrange for a number of Papers to be circulated to members at convenient intervals during the winter. These Papers will be available for inclusion in Branch programmes for discussion, as also will the Papers which are being arranged for discussion at the annual general meeting.

Buchanan Awards

The following candidates in the City and Guilds of London Institute Examinations in Foundry Practice and Science and in Patternmaking have received awards from the Institute of British Foundrymen.

Patternmaking

Buchanan Silver Medal.—No award was made.

Buchanan Book Prizes.—Ronald Hollingworth, Old Bilton; and Lancelot Bell, Thornaby-on-Tees.

Foundry Practice and Science

Buchanan Medal.—Frank Lord, Clayton-le-Moors, Lancs.

Buchanan Book Prizes.—T. J. Parkes, Sheffield; J. L. Younger, Dursley, Glos; and C. E. Webster, Keighley.

Soviet Institute of Metallurgy

Designs of a building to house the new Institute of Metallurgy of the Academy of Sciences of the U.S.S.R. have been completed and approved. It will have four storeys, with an aggregate useful area of 75,400 sq. ft. and a total volume of 2,300,000 cub. ft. The designs provide for several groups of laboratories—a physico-chemical group, in which will be studied the theoretical principles of metallurgical processes, and a physico-technical group, where will be studied the properties of solid and liquid metals and research conducted on new alloys. Provision is made for a large group of laboratories for prosecuting research on pig-iron, steel and non-ferrous metals, and refractory materials. For experimental steel melting a 1- to 2-ton open-hearth furnace is to be installed, and for iron a fair-sized cupola.

Position of Aluminium and Magnesium in the U.S.A.

Some interesting facts as to the potentialities of American industry to provide the aluminium and magnesium required by the National Defence Programme are revealed by two articles in the December issue of "Metals and Alloys." DR. COLIN G. FINK (of Columbia University) deals with aluminium and MR. L. B. GRANT (Dow Chemical Company) with magnesium.

Dr. Fink points out that, since 1919, the world's output of aluminium has doubled every 10 years, and that Germany early in 1933 started upon an extensive production campaign. By 1939, German production attained 200,000 metric tons as against 150,000 tons for the United States. However, there is every indication that the 1940-1941 American production may exceed that of Germany. The Aluminum Company of America has a programme involving the expenditure of $60,000,000. A new reduction plant is being built on the Pacific Coast with a capacity of 15,000 tons of aluminium metal per year. Canada, which possesses one of the largest aluminium plants in the world, has a yearly production equalling half that of the U.S.A. and of which 96 per cent. is exported.

Magnesium

Mr. Grant observes that U.S. magnesium production, now of the order of 12 million pounds per annum, is much lower than that of one European country, which produced 38 million pounds, because the latter, being a totalitarian State, was ordered to do so, while in America the situation has been governed by private enterprise. Nevertheless, under this condition, output grew steadily from half a million pounds in 1930 to 10½ million pounds in 1939. A plant is now nearing completion which will bring the capacity up to 25 million pounds per annum. In 1915, the price of magnesium was $3.50 per lb. as against the current figure of 27 cents per lb.

For the production of magnesium alloy castings over 30 well-equipped foundries are located in the chief consuming areas, mostly in the East, Middle West and Far West. These foundries are prepared to supply the intricate castings required for many aircraft parts, and are sufficiently decentralised so that bottlenecks are less likely to occur.

At present the principal requirements are for sand castings and die-castings. Parts for which castings are used include crankcases, blower sections, accessory housings, pump bodies, landing wheels, door and seat frames, levers, pedals, instrument cases, and other parts. Application is being made of sheet metal and extruded shapes for cowling, fairings, mouldings, and similar parts.

INDEX TO VOL. 63 NOW READY

The index to the editorial contents of Vol. 63 of the Journal (July to December, 1940) has now been printed. Readers wishing to receive a copy are asked to make early application to our Publishing Department, 3, Amersham Road, High Wycombe, Bucks.

Titanium in Steel

The January, 1941, diary issued by T. Rowlands & Company, Limited, of 23-27, Broomhall Street, Sheffield, has as an inset a short, but illuminating, article on "The Function of Titanium as an Alloying Element in Steel," by Dr. E. C. Bain.

Random Shots

Two stories have come to "Marksman" this week, which, though they are both hard to swallow, are nevertheless quite true. The first concerns a salmon which was caught in the River Severn and which eventually found its way into a fishmonger's shop in Sevenoaks. When caught it weighed close on 17 lbs., but when it was cut up by the fishmonger it was found to contain a home-made tool for setting the teeth of double-handed wood saws. This metal instrument weighed 11 ozs. and was $\frac{5}{16}$ in. thick . . . definitely hard to swallow!

* * *

The second story concerns a certain works manager, who prides himself on being a very practical man. Urgently requiring some castings which he had ordered, he sent his assistant down to the foundry to see how soon they could be delivered. The young man came back with the message that the coring was well under way, and that casting would be started in two days' time. Whereat the manager was very angry and roared to his assistant, "'Phone them up and tell 'em not to bother with this coring business, but to get on with the castings and send them up right away!"

* * *

"Marksman" spotted in "Oxyacetylene Tips" the other day the statement: "By using an iron rod as a stirrer and fluxing agent, flame gouging can successfully be done on steel impregnated with sand." Can this possibly refer to a steel casting?

* * *

That's the Stuff!

Two women met in the market place to do their shopping.

"I didn't think I would see you to-day," said one by way of greeting. "It was pouring with rain when I left home, and to make matters worse the Alert had to sound just as I shut my front door."

"I must say I don't like the rain," answered her friend, "but I didn't mind about the Alert. I knew our boys would send 'em back before I got here. And wasn't I right, for there goes the All Clear!"

* * *

"How do you spell 'cajoling,'" asked the teacher.

"C-a-d-g-o-l-i-n-g," promptly replied little Johnny, who was an expert at the double art.

* * *

A correspondent in the "Times" has observed that thousands of yards of cloth might be conserved by an order forbidding trousers to be made with turn-up ends. "Marksman" feels sure that the Cardsharper's Union would strongly oppose such a move.

* * *

A good deal of ironical publicity has been given by the Press to this advertisement, which appeared in one of our national dailies: "Second footman or second parlourmaid required at once; four in family, 13 servants, including four in pantry." With the meat ration so small, those four in the pantry had better look out.

* * *

Fears that the suppression of a certain newspaper will drive its supporters' activities underground will, "Marksman" imagines, prove to be groundless. With all the available space underground already occupied, it is more likely that any subversive activities will be driven to the attic in future.

"MARKSMAN."

One Way of Making a Loam Mould*

By JAMES POTTER

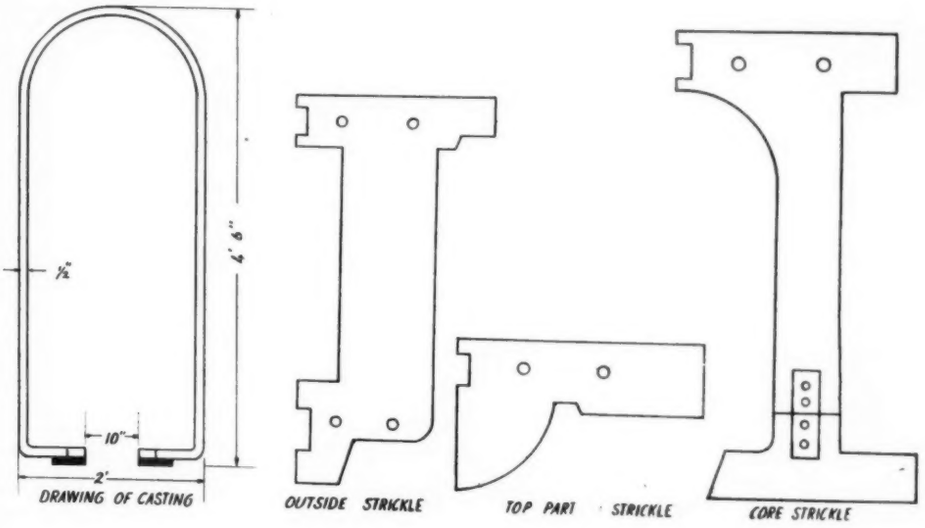
The title of this Paper has been deliberately chosen for the simple reason that there are many ways of making the same mould, but the "one way" is that favoured by the author. Possibly it may be thought that this method is not so very good, in which case a good discussion should ensue. In loam moulding a certain amount of foresight is essential, for it is necessary to envisage the construction and apply the picture so obtained in practice. For illustration of this precept it is proposed to describe the steps to be taken for the moulding of a Diesel engine silencer. As a rule, for the making of such a job, the moulder is supplied with a blue print and a set of strickles. Initially he studies them and builds up the mould in his mind, and thereby determines what will be required in the way of plates and their tackle. For the sake of clarity, the requirements are illustrated, and have been given the following numbers: (1) the bottom plate for the cope; (2) (3) and (4) three building rings, and (5) top plate. This embraces all the "outside" tackle.

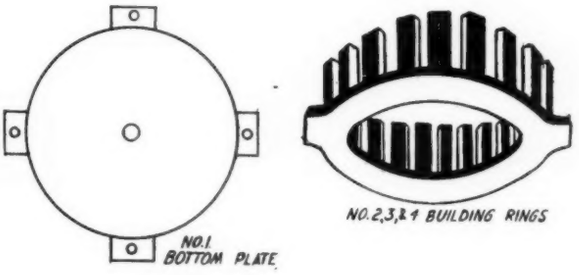
For the core, the requirements are (6) a plate for the bottom of the print carrying two cast-on bolts so that it can be fastened to (7) the next plate, which has two holes cast into it to fasten through the top plate of the core. As the job is built up the next plate for use (8) is a split ring for reinforcing the middle of the core. Item (9) is the top plate in the core; this has three holes cast in it for the three bolts of plate (7) to register, and so bolt the top and bottom of the core together. Top plate (9) has also three staples cast into it for picking up the core when dry.

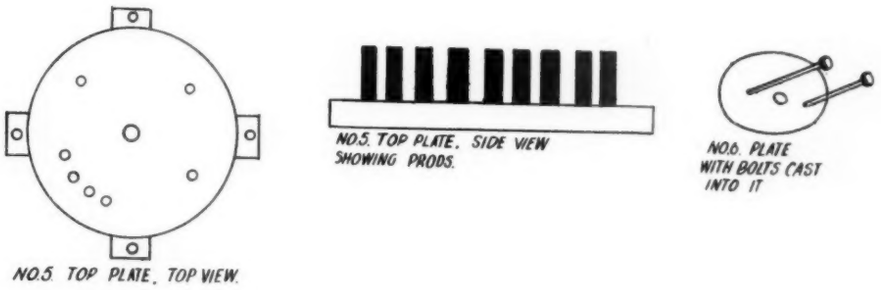
Having made the core, which is the most difficult part of the job, the outside can be profitably discussed. The moulder first places the bottom plate (1) in position on to a spindle centre, and sets the spindle and strickle to run true with it. He then places a layer of bricks on the bottom plate, and fills all the spaces in between the bricks with fine dry ashes or coke. This will enable the gases to escape from the bottom of the mould quickly. He next places building ring (2) in position on top of the layer of bricks, and proceeds to build with bricks to within ½ in. of the strickle face, this gap being left to be filled in with loam. The moulder carries out the same procedure with the building rings (3) and (4), finishing the top joint with a taper seating for taking the top plate, which must match and fit in snugly. With regard to the loaming of this job, it is best done in three stages: (1) rub the loam well into the brickwork, and use it as stiff as possible; (2) let this course dry a little, and then make up the cracks which will appear in it, and (3) rub well into the first coat a thin loam. This will leave a nice surface, only requiring the slip loam to be put on with a soft brush, the board being worked with the taper edge in place of the cutting edge.

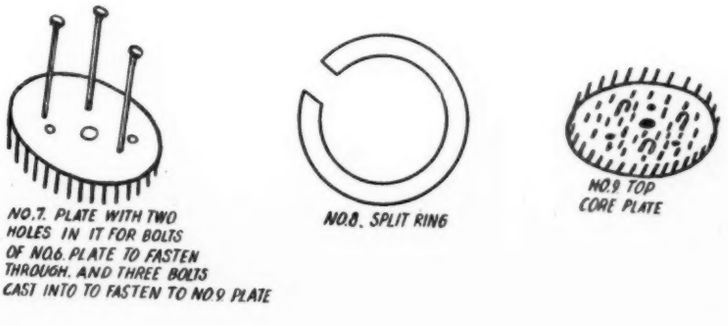
The time has now arrived for the top plate (5) to be set level, as was the case with (1). In bricking up the top plate a little more care must be exercised, for the simple reason that when the top is dry it has to be turned over with the bricks suspended on the underside of the plate. When making the plate care had to be taken for the proper spacing of the prods so that when cast a brick could just be knocked in between each prod without much chipping. Any bricks that fail to fit tightly can be wedged in with brick chippings. When all the bricking is completed, the four down-runners and three riser pegs are placed in position, and the mould loamed up, the whole being then placed into the stove for drying. After drying and while the job is still warm, the accuracy of the dimensions is checked with gauges. Naturally this has been done on several occasions during the period of building. The various components are wet-blacked with a brush, and allowed to dry. The core is then placed into the mould, care being taken to ensure that the seating at the bottom is so made that no metal can enter the vent. A hook bolt is passed through the centre hole in the bottom plate so it will fasten on to plate (7), and secure the core firmly while the mould is being cast. The three staple holes which were used for lifting the core are "made-up," as is also the spindle

(*Continued on page* 86.)








NO.7. PLATE WITH TWO HOLES IN IT FOR BOLTS OF NO.6 PLATE TO FASTEN THROUGH. AND THREE BOLTS CAST INTO TO FASTEN TO NO.9 PLATE
NO.8. SPLIT RING
NO.9 TOP CORE PLATE

* Paper read before the Burnley Section of the Institute of British Foundrymen.

D

Iron-Nickel Alloys

CONSTRAINED SECONDARY RECRYSTALLISATION

It is frequently observed in high-quality cold-rolled material that new nuclei of recrystallisation form spontaneously in the fine-grained structure produced by primary recrystallisation, the number of these secondary nuclei being much less than that of the primary grains. Grain growth due to the appearance of these nuclei always results in the final grain becoming too coarse. In "Metallwissenschaft," H. G. MÜLLER refers to this type of behaviour, which has been observed in the case of nickel-iron alloys with 40 and 60 per cent. nickel and of pure nickel, all of which after 90 per cent. cold reduction revealed cubic recrystallisation, and on further heating to very high temperatures acquired a coarse-grained structure with a uniform orientation derived from the cubic structure by about 30-deg. rotation about the direction of rolling. This phenomenon has been described as free or unconstrained secondary recrystallisation, since spontaneous nuclear formation is characteristic of it. In general, a specific limiting temperature can be deduced for each material, which must be exceeded to initiate this form of secondary recrystallisation. This temperature has been found to increase as the percentage of impurities in the samples is raised.

On the other hand, in those cases where free secondary recrystallisation does not occur at all or under the particular conditions operating, coarse crystallisation can be induced by submitting the already highly deformed material to a second reduction or other physical distortion before reheating. It is essential for the second reduction or distortion to be fundamentally different from the primary stage. Thus Masing caused the formation of large grains by perforating, drilling, or distorting high-quality tin and zinc after once rolling. Those areas which had undergone double deformation then always revealed the presence of coarse grains, and to describe this phenomenon Masing introduced the term "constrained or enforced secondary recrystallisation," since he regarded the process as one of secondary recrystallisation. But later experiments by van Arkel and Ploos van Amstel indicated that Masing could only have brought to light a hidden primary recrystallisation, since, especially with high-quality tin and zinc, primary recrystallisation takes place very rapidly already at room temperature, and hence Masing's specimens had probably already recrystallised before being subjected to the second and apparently critical deformation. On the other hand, various observations made on tungsten filaments and other heating elements seem to indicate that constrained secondary recrystallisation is indeed an entirely independent recrystallisation phenomenon, for if filaments before normalising are coiled, exceptionally large crystals are later found to appear at the points of greatest curvature.

H. G. Müller calls attention to a particularly instructive example of this type of secondary recrystallisation, *viz.*, an iron-nickel alloy containing 50 per cent. of nickel, which after hot-rolling was reduced by 98 per cent. by cold-rolling to 0.35 mm. and then reheated to 1,000 deg. for 1 hr. It may be noted that the temperature of recrystallisation of this cold-rolled alloy was about 500 deg. After treatment, all samples exhibited the uniform fine-grained texture of a cubic structure. The linear dimensions of the crystallites in the cubic structure were 10 to 20μ, and only when the temperature had been raised to 1,100 deg. and above did the orientated coarse granulation of unconstrained secondary recrystallisation occur. But if, after cold-rolling, the specimens were sheared at the edges and then heated for an hour at 1,000 deg., coarse crystallisation occurred quite clearly at the trimmed edges. Grain growth then starts where the metal has been sheared, and some of the coarse crystals grow to a size of 1 cm. Their orientation does not appear to be connected in any way with the cubic arrangement in the original structure. That the arrangement of the crystals is completely haphazard was confirmed by radiographic examination.

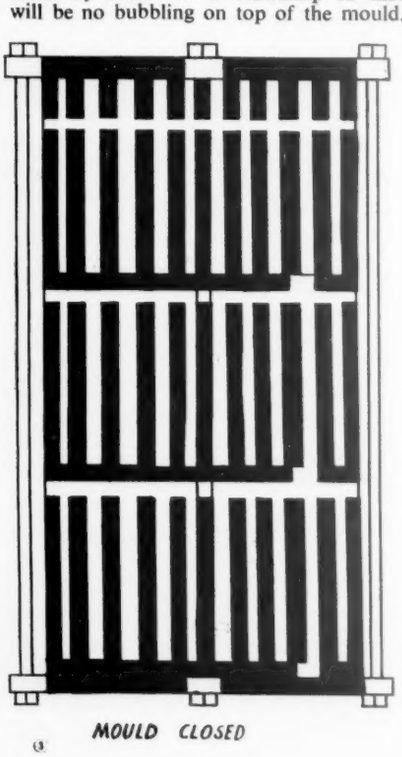
In rolling-mill practice, the appearance of these coarse crystals is very undesirable, since in proportion to the width of the strips the pronounced magnetic properties associated with the cubic structure are affected more or less adversely by a divergent orientation in the edge regions. Those coarse crystals deviating from the cubic structure lower the remanence of the normalised strips to such a degree that the rectangular character of the hysteresis loop is lost. Attempts have therefore been made to prevent the initiation of enforced secondary recrystallisation by re-rolling the trimmed samples before reheating. Tests with reductions in re-rolling of 15, 30 and 50 per cent. for this purpose have been made, and etched diagrams of the strips after reheating for 1 hr. at 1,000 deg. indicated that 15 per cent. reduction is already sufficient to reduce considerably the number and size of the coarse crystals, while with 30 per cent. reduction grains of secondary recrystallisation occur only sporadically; 50 per cent. reduction completely inhibited the phenomenon.

The iron-nickel alloy used here is regarded as exceptionally suitable for studying secondary recrystallisation, since constrained or unconstrained recrystallisation can be initiated by varying the normalising temperature and the initial treatment. Samples cold-rolled merely to 98 per cent. reduction in thickness revealed secondary recrystallisation only when normalised above 1,100 deg. The energy value of the displacements in the primary recrystallised structure, which later act as the nuclei of free secondary recrystallisation, is therefore so small that nuclei are formed and can develop only at this high temperature. In the case of enforced secondary recrystallisation, secondary deformation (in the present case distortions in the lattice in the neighbourhood of the sheared edges) increases the energy value to such an extent that nuclei initiating coarse crystallisation can form already at a much lower temperature. This is in agreement with the interpretation advanced by van Liempt of the mechanism of enforced secondary recrystallisation, according to which the two different types of deformations result in variations in stress having different wavelengths. At all points where two stress troughs are superimposed, the distortion of the lattice is considered to be particularly pronounced, and these distortions are only partially removed by primary recrystallisation, the residue providing the nuclei for secondary recrystallisation following reheating.

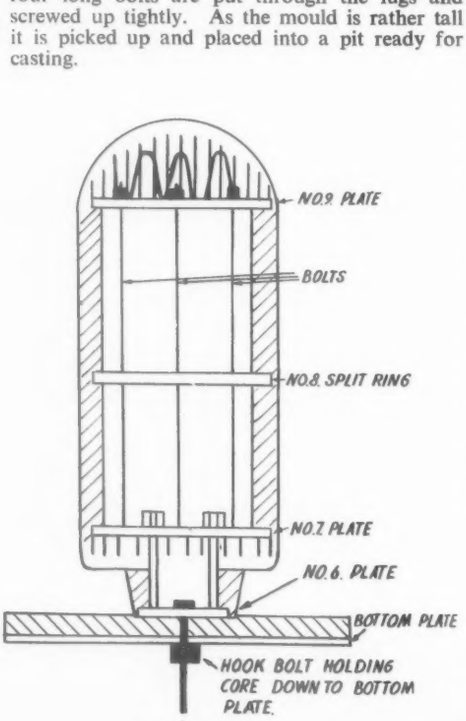
One Way of Making a Loam Mould

(*Continued from page* 85.)

hole in the top of the core. These are then dried by means of a blowlamp so that there will be no bubbling on top of the mould. The top is placed in position, being set correctly in its taper seating; then the runner and riser bushes are placed into position, and finally the four long bolts are put through the lugs and screwed up tightly. As the mould is rather tall it is picked up and placed into a pit ready for casting.



MOULD CLOSED



COMPLETE CORE

Outsize Stress-Relieving Furnaces

Two American navy yards have installed what are thought to be the largest convection-type furnaces in existence. These two similar furnaces are used for stress relieving and were designed by the Surface Combustion Corporation, of Toledo, Ohio. Each furnace is 56 ft. long by 48 ft. wide by 30 ft. high, and takes a 300-ton charge. With a gas input of 16 million B.T.U. per hour, it takes 36 hours to raise the charge to 675 deg. C.

Railings in Peace and War

VALUABLE SOURCE OF SCRAP FOR MUNITIONS

By "PALUS"

One day someone will write an epic poem on the subject of iron. There is a great story to be told; and an old story, for iron has been worked practically since history has been recorded. It belongs to the historic as opposed to the prehistoric geological periods. Of all the raw materials provided by nature and used by man for his purposes, his arts and crafts, his implements and habitations, his service and support, three are outstanding—stone, wood, and iron. Of these, iron has ever given strength to the other two.

In some ways it takes a humble place among the metals. It has not the beauty of gold and silver, nor the superlative special qualities of, say, platinum, copper or aluminium. But for general utility it is unrivalled. A chronicler of the iron industry has described it as standing precisely among the metals as the working classes stand in a civilised community. Also, it is a good mixer and, combined with other substances, has an amazing range of qualities.

It is true, many beautiful things have been wrought in iron. But even here, where the craft of the smith finds its greatest perfection, the use of iron is generally protective, either to keep out the intruder or to save the occupier from accident and injury. For example, the gates, railings and grilles so common in London houses, interior and exterior balustrades, and the exquisitely wrought gateways and railings that adorn the Backs at Cambridge and the gardens and cloisters of the Colleges of Oxford, all serve one or other of these purposes.

The twenty-three pages of the London Telephone Directory occupied by the name Smith afford eloquent and hereditary testimony of the ubiquity of the craft that gave us this common but honourable name. The smiths worked in iron; the wrights worked in wood. In husbandry, the wright was indispensable—be he cartwright or wheelwright. In warfare, the smith was a necessity. He and his forge accompanied every warlike expedition. Horseshoes, arrowheads, armour, javelins and axes were provided by him. It is worthy of note that the words "smith" and "smite" have a common origin.

There is no space here, nor is the writer qualified to perform the task, to trace the history of ironworking from remote times to the present, when the whole of our civilisation, with its ships, railways, buildings, vehicles, streets, and thousands of machines of all kinds, seems to be built on a basis of iron and steel. It is enough to say that classic and mediæval history discloses that everywhere where men were formed into the rudiments of a civilised society, iron was worked, and a wealth of objects and implements left over from those ancient days affords tangible evidence of the service this metal thus early gave to man.

The recovery of the metal from its ores was then, as now, by smelting, but the universal fuel was wood. In this country the occurrence of iron-bearing formations in thickly-wooded areas dictated the areas where the iron industry was located. The weald of Sussex and Kent, the Forest of Dean stretching along the banks of the Severn into Wales, principally, and other districts where the necessary conditions prevailed, provided the early home of our iron industry.

As the first patent for smelting iron with coal was not taken out till 1611, and the new method was not really worked profitably till a century later, it is clear that for many centuries wood fuel was necessary for the production of iron. Since, at the same time, the labour required to fashion the metal was manual or provided by primitive water-driven machinery, obviously the output bore no relation to that of modern times. The average annual output of a furnace was under 100 tons.

The use of iron was therefore restricted. Weapons of offence and defence provided the first obvious use. In other directions where strength or resistance to heat or weather were necessary, iron was used where possible—hinges and hasps, and irons and firebacks, window-guards, frameworks for doors and windows, iron bands and locks, grilles for windows and doors; uses such as these were those to which iron was most commonly put. There were, of course, both in ancient and mediæval times, objects, primarily artistic, which were fashioned of iron, but these were the exceptions. It was not till a comparatively later period that iron was used, to any extent, for railings with which we are here concerned.

Early Use of Railings

Their first use seems to have been to surround places of special veneration—monuments and the shrines of saints, burial places, sanctuaries and chapels. Iron railings of this type appear to have come into use about the time of Edward I. An early example is to be seen around the tomb of the Black Prince in Canterbury Cathedral. Edward IV was responsible for the magnificent rail of gilded iron in St. George's Chapel, Windsor.

Perhaps for climatic reasons no examples remain to us of outdoor railings from mediæval times, though the existence of some—for instance, those that surrounded the Eleanor Crosses—is known. Such as there were of these examples of the craft of the smith have disappeared. Indeed, there appears to have been a lean period in the production of smiths' work in this country during the Tudor and Stuart periods. In addition there was an influx of foreign craftsmen in the time of Henry VIII.

Towards the end of the seventeenth century came a great revival of decorative ironwork in England. Perhaps because the times were more settled, perhaps because at this time and through the following century there was a succession of notable architects, such as Wren himself, Isaac Ware, James Gibbs, Vanbrugh, and later the Adam brothers, and partly perhaps because of foreign influence.

Work of Jean Tijou

William and Mary of Orange brought in their train a great master-smith, Jean Tijou, perhaps more accurately described as a designer of ironwork. Tijou, in his twenty years' sojourn in this country from 1690-1710, not only left us many examples of his own genius, but he published a book of designs which was an inspiration to those who followed him. He was closely associated with Wren in much of the latter's work. The railings round St. Paul's Churchyard—the most important early work of the kind in cast iron in this country—and gates and railings at Hampton Court were by Tijou. All over the English counties are still to be found beautiful gates and adjoining railings wrought by him.

He was followed by other notable smiths. Thomas Robinson, a Londoner, with works at Hyde Park Corner, was perhaps the most eminent. His work was simpler and more English in style than the ornate designs of Tijou. He was responsible for the wrought-iron railing and balustrade work, inside and out, at St. Paul's Cathedral, and to him we owe the beautiful, slender railings in the gardens of New College, Oxford. Other notable smiths were the Roberts brothers, Bakewell and Warren. The last named produced the gates, formerly of Devonshire House, now set in the railings bordering the Green Park.

Between them the architects and the smiths, partly in the erection of public buildings, sacred and secular, and partly by aiding the idle rich of the period to perform their true function of setting a standard of living which might percolate to other classes, gave us a rich and beautiful heritage of gates, balustrades and railings which combine in an unusual degree the qualities of the ornamental and the useful.

But on the whole it was only very gradually that iron superseded wood as the material for outdoor gates and railings. Clearly, to surround a park or estate or even a city square, much more material was required than for a pair of gates or a window balustrade. It must be remembered that until well into the seventeenth century wood fuel was still used in the production of iron. Indeed, at the beginning of the eighteenth century, the amount of iron produced had, owing to the growing scarcity of wood, fallen very considerably, as compared with a generation before. The production, too, was laborious. It had long been known that by creating a "blast" the metal could be liquefied and run off into moulds, but cast iron was not, until much later, looked on with favour in England for the purposes we are considering. It was used for cannon and shot and certain other rougher objects, but was ill-adapted for the finer work of the smith. Though, as we have noted, the railings at St. Paul's were cast, this form of the metal only came into general use for this purpose at the beginning of the nineteenth century.

Railings in London

So it was quite late in the day that railings generally were erected. In London the squares and parks were either surrounded by walls or fences or left as open spaces. A subscription to replace the wood palings in Lincolns' Inn with iron railings was opened in 1748. In the same year, Soho Square was fenced in with iron, and Golden Square followed the new fashion a little later. Hanover Square acquired its iron railings about 1780, a little later than Grosvenor Square and St. James's Square. As late as 1790 the Piccadilly side of Green Park was bounded by a wall, into which sections of railings had been set. George IV had Hyde Park enclosed by railings, and early in her reign Queen Victoria extended the same treatment to Kensington Gardens, which up till then had been enclosed by a wall. Area rails were common in London at an earlier period, many of them, particularly the work of Robert Adam about 1770-1780, of beautiful workmanship. Much of his work still survives.

With the advancing nineteenth century, the firm establishment of the iron industry on the coalfields, the increasing use of machinery to replace the manual labour of the smith, the building of blast furnaces which produce cast iron at something like a thousand times the rate of the old furnaces, the puddling furnace patented in 1784 which gives the malleable metal required for the work of the smith, iron entered into the soul of civilisation.

In the Victorian era, railings sprang up everywhere. The zest for enclosing everything, recently defended by an eminent publicist in one of the weekly journals on the ground of the privacy it afforded, gave the railing-monger a new excuse for his existence. Every suburban dwelling, semi-detached or terrace house, had its iron enclosure. The iron-railing and the privet-hedge became as indispensable to each front garden plot as was the aspidistra in the

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parlour window. In parks and recreation grounds interminable rows of straight ugly iron palisades bade the public, the owners of these open spaces, to keep off the grass. Following the example of the buildings they enclosed, tall iron railings more suitable to a prison were erected round the asphalted playground of each elementary school, giving to the growing child a supreme example of what ugliness can achieve. The cheapness and abundance of iron accomplished all this and much more.

Railings Challenged

So for nearly a century the railing has remained with us in its ubiquity and profusion, accepted without question as part of the normal order of things by most, adored by the jerry-builder, and abhorred by the discriminating few. Suddenly about a year ago, the railing was challenged. The nation needed iron and steel; needed them in greater quantities than ever before. Inquisitive persons began to look here and there and pry into the material fabric of our civilisation to see where iron could be found, iron that was not wanted and that could be devoted to the urgent need of armament manufacture. So arose the great railings controversy. Millions of the British public who had never thought about railings in their lives began to think about them and to talk about them.

Of all the subjects dealt with in the public Press calling for scrap metal, nothing has aroused so much interest as this question of railings. After all, everybody knows what a railing is. So the columns of the Press were daily filled with discussions about railings, reports of debates on Town Councils about railings, letters from vicars about railings in church-yards, and from every "Constant Reader" about railings in general. Some were prepared to sweep away all railings; others had certain pet railings they were anxious to preserve. Public opinion as reflected in the Press was overwhelmingly against the railings. "The Railings Must Go" became almost a public slogan. The admirable Railings Exhibition held at the Building Centre in Bond Street, and the publicity given to it, did much to educate opinion. This Exhibition has been shown in other parts of the country with equal success.

The Office of Works, as custodian of the Royal Parks, set a good example. The London County Council followed suit. Municipalities all over the country fell into line. Inland cities uprooted the railings round parks and squares; seaside resorts denuded their promenades of redundant ironwork. Officers of the Royal Institute of British Architects gave the movement their blessing, and learned societies such as the London Society, interested in the beautification of our Capital City, welcomed it.

The general public took a keen interest and became inquisitive. Certain difficulties arose: for instance, could a railing round a grave, even if broken down, be removed without a faculty from the Diocesan officials? How did a tenant stand with his ground landlord if a public authority asked for the railings in front of his house? What about the rights of the leaseholders who held the key to a London square and had the exclusive right to use it? But these are comparatively trivial matters, and common sense has solved, or will solve, them. So, too, with the hundred and one local controversies revealed by the Press as to whether this or that set of railings is or is not beautiful or ugly, historically interesting or of no account, should be sacrificed or should be spared.

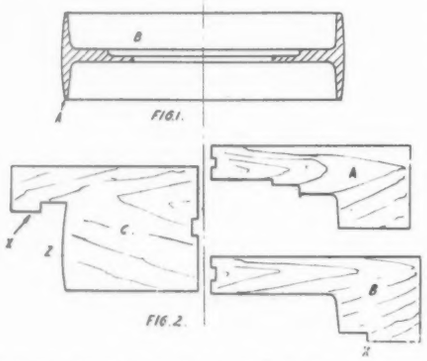
The main point is that in face of the national need, the retention or destruction of a very common feature of town architecture, and a method of enclosure widespread in urban and rural areas alike, has become a matter for

(*Continued in next column.*)

Some Jobbing Foundry Experiences—XVII

By "TRAMP"

Fig. 1 is a type of loose pulley sometimes required from jobbing shops. Instead of being attached to the shaft by a boss this particular wheel is in the form of a ring which is bolted to a coupling face. The mould for this example can be swept by two boards, but a better casting is obtained if three were used, as by the former method difficulty might be experienced in black-washing the rim A, especially if the thickness were small compared to the depth. Face B is cast down, and as much of the mould as possible is swept in the bottom. The necessary sweeping boards are shown in Fig. 2. A sweeps the bottom, B the cope, and C the ring or middle. This board is used as follows. A foundation plate is used to form a true bed, and board C is fastened in position. A thin layer



of loam is then laid on this bed outside the limits swept by the striking edge Z. A cast-iron ring with suitable teeth cast on is then embedded into this loam and used as a foundation for building the remainder of the ring of brickwork; a coating of loam ¼ in. thick being swept on, this part is ready for stoving. Assembly is commenced by placing the bottom in position, then lowering the ring over this, centring being done by suitable gauge sticks, and the top is then positioned by the guides swept by X on boards B and C.

(*Continued from previous column.*)

decision. In general, shall railings stay or shall they go? Again in general, there is no doubt that the British public has turned down its thumb. But there is very solid and responsible opinion against the wholesale and undiscriminating sacrifice of all railings just because they are made of iron. Speaking generally, they have served their turn. Faced with the need of the material of which they are made we find we do not want them. But in the brief and incomplete sketch given above, an attempt has been made to indicate what more competent persons have asserted, that there is much of real artistic and historic interest that is worth preserving. So we must keep our sense of proportion.

One of the leaders of the Georgian Group has suggested that all railings dating from before 1850 should be saved and all erected after that date sacrificed. This, he writes, roughly divides the age of craftsmanship from the period of mass production. The date may not be the best to select, but the criterion is good. Certainly if there is anything in the nature of compulsory requisitioning it should be accompanied by a vote, to be exercised by, say, the Royal Institute of British Architects, against the destruction of anything properly described as the work of the craftsman.

Cerium Additions to Cast Iron

An article which has appeared in "Die Giesserei," written by W. BAUKLOH and H. MEIERLING, has been abstracted by "Metals and Alloys" as follows:—

Existing literature shows that cerium favours the formation of white iron, and aids in the removal of impurities, particularly oxygen, nitrogen and sulphur. Experiments are described in which a cerium alloy of 51 per cent. Ce, 46.9 other rare earths, 0.13 Si, 0.55 Fe, 0.62 Mg, 0.03 Al, and 0.02 per cent. Ca was melted and added to a ladle containing 120 lbs. of liquid cast iron.

The cerium content of the finished metal was always much lower than the amount of cerium added. Some of the lost cerium goes into the slag, and some of it burns off. The sulphur content is considerably reduced and the tensile strength noticeably increased by cerium additions in which the cerium content of the finished casting varied between 0 and 1.5 per cent. (2 per cent. addition), depending on the amount and manner of cerium alloy addition. The Brinell hardness increased from 209 (no cerium) to 237 (2 per cent. addition).

A very remarkable effect seems to be exerted on the fluidity; when tested by the Sipp method (casting a spiral of given dimensions) the maximum fluidity was obtained with a cerium addition of 0.50 per cent.; this remained about the same to 0.75 per cent. and then dropped again up to 2 per cent. Ce addition. The increase in mechanical strength is ascribed to the fact that cerium is a carbide former and thus hinders graphitisation. On the other hand, part of the CeC_2 formed burns away in pouring, forming fine cerium oxide particles; these are finely distributed in the melt and can be considered as nuclei for graphite formation. Furthermore, CeC_2 disintegrates in cooling to CeC_2 + C + heat, and the carbon thus formed also acts as to initiate graphitisation.

Desulphurisation is connected to a certain extent with the increase in liquidity, due apparently to the exothermic reactions that occur after addition of the cerium alloy; a 30 deg. C. increase in the temperature of the iron could be observed. Since the melting point of the iron was reduced by only 5 deg. C. by the addition used in these tests, the greater fluidity cannot be attributed to melting point lowering.

This greater fluidity can be utilised to advantage for special cast irons, and for thin-walled castings, for the mechanical strength is simultaneously improved. The increase in tensile strength was approximately linear from 12 tons per sq. in. at 0 per cent. Ce to 25 tons per sq. in. for 2 per cent. Ce addition. The sulphur content was reduced from 0.12 to about 0.02 per cent. in the same cerium addition range.

Family Allowances

The Midland Electric Manufacturing Company, Limited, of Birmingham, manufacturers of M.E.M. switch, fuse and motor control gear, have just introduced a scheme of family allowances, in addition to "supplementary grants" which are already paid to all employees to offset the normal rise in the cost of living. The directors, realising that the extra cost of living falls more heavily on a married man with a family than on a single man, have worked out a scheme which provides additional weekly payments for each dependent child. The scale is generous—a married man with three children will receive 6s. per week additional to the present supplementary grants. The scheme, which it is hoped to operate at least for the duration of the war, applies to all works employees and to members of the staff below a certain salary level. The new arrangement is an extension of the M.E.M. policy of full consideration for the older and more mature type of worker.

Metallography of Inclusions in Cast Irons and Pig-Irons

By H. MORROGH (British Cast Iron Research Association, Birmingham)

(*Continued from page* 78.)

So far in this Paper, the colour of the titanium sulphide inclusions has been referred to as blue-pink. Actually, this constituent is pleochroic, and its colour varies from blue to pink, according to its position relative to the plane of polarisation of the incident light. There is no need to use a polariser in the microscope train to obtain the effect. The reflection of light from the glass-slip vertical illuminator produces enough polarised light to give an easily discernible change in colour on rotating the stage of the microscope. The use of a polariser merely increases the pleochroic colour contrasts. When a lamellar idiomorphic titanium sulphide inclusion is arranged parallel to the plane of polarisation of the incident light it appears pink, and when it is arranged at right angles to the plane of polarisation of the incident light it appears light blue. Intermediate positions show intermediate colorations, but the pink tends to predominate.

FIG. 43.—EUTECTIC-LIKE VANADIUM-CARBIDE AND IRON-SULPHIDE-RICH INCLUSION. 2-MM. OIL-IMMERSION OBJECTIVE. UNETCHED. × 2,000.

When a lamellar idiomorphic titanium sulphide inclusion is examined under polarised light between crossed nicols, it lights up and extinguishes four times for a complete revolution of the microscope stage. Extinction occurs when the length of the inclusion is parallel to either the plane of polarisation of the polariser or to the plane of polarisation of the analyser nicol. The inclusion lights up in positions at 45 deg. to these directions.

When an idiomorphic titanium sulphide crystal with a hexagonal outline is examined under polarised light between crossed nicols, it remains dark for all positions of the stage, and under plane polarised light no pleochroic effect can be observed—it appears pink for all positions of the inclusion relative to the plane of polarisation of the incident light. These facts further support the view given above, that the hexagonal crystals are probably cross-sectional views of the idiomorphic lamellar titanium sulphide, since tetragonal and hexagonal crystals are singly refractive in the directions of their principal crystallographic axes, and rhombic, monoclinic and triclinic crystals are singly refractive in one or the other of the two optical axes. Of course, these facts only apply to transparent sections, but the implications of these observations are that the idiomorphic titanium sulphide crystals are prisms of hexagonal form, and the hexagonal nature of the crystals is only revealed in the comparatively rare cases when the polished surface of the specimen cuts cross-sections of the prisms.

Melt No. 12 showed complex formations of vanadium carbide, titanium sulphide and iron sulphide rich in titanium and manganese sulphide. The vanadium carbide in this sample frequently occurred in eutectic-like patches adjacent to eutectic-like sulphide-rich constituent. A typical example of this is shown in Fig. 43.

FIG. 44.—VANADIUM CARBIDE WITH MANGANESE-SULPHIDE AND IRON-SULPHIDE-RICH CONSTITUENT. OIL-IMMERSION OBJECTIVE. UNETCHED. × 2,000.

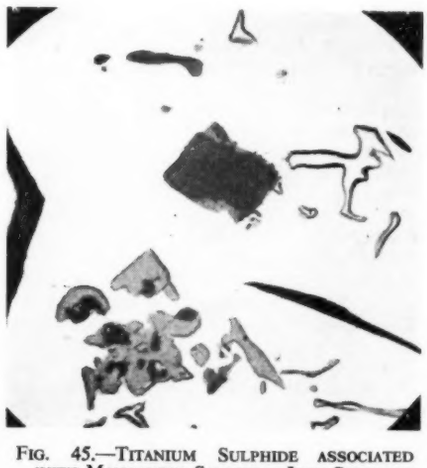


FIG. 45.—TITANIUM SULPHIDE ASSOCIATED WITH MANGANESE SULPHIDE, IRON SULPHIDE AND VANADIUM CARBIDE. 2-MM. OIL-IMMERSION OBJECTIVE. UNETCHED. × 2,000.

Figs. 44 and 45 illustrate the intimate occurrence of vanadium carbide with manganese sulphide, and of titanium sulphide with manganese sulphide. Melts Nos. 11 and 17 showed large amounts of an iron-sulphide-rich constituent which was not attacked by etching for 5 min. in a 1 per cent. aqueous oxalic acid solution, this indicating that this constituent was essentially the same as the khaki-grey constituent present in melt No. 1. Melt No. 17, which gave a mottled fracture, had some very interesting graphite formations. The graphite was arranged in very thin lamellæ around the lakes of cementite, also suggesting that it was the product of a reaction in the solid state. Typical micrographs of these graphite structures are shown in Figs. 46 and 47. Wells,[51] when studying graphitisation in high-purity iron-carbon alloys, found graphite precipitated round cementite and also as a Widmanstätten graphite pattern in cementite in annealed white irons. This would seem to imply that melt No. 17 solidified white and that some of the cementite decomposed after solidification.

Although the results obtained from the melts so far described indicate that if there is sufficient manganese to balance the sulphur content no titanium sulphide will be visible, one example has been found where this was not the case; this was a 15 per cent. silicon iron. A charge of 15 lbs. of steel, 15 lbs. of 10 per cent. ferro-silicon and 20 lbs. of 30 per cent. ferro-silicon was melted in a salamander crucible, using a coke-fired, forced-draft furnace. When the charge was molten, 1 lb. of ferro-silicon-titanium was added, and when this was dissolved, carbon dioxide was bubbled through the melt for 2 min. After this treatment, four test blocks, each measuring 8 in. by 4½ in. by 1¼ in., were cast on to a chill in an open mould. The purpose of the titanium and carbon-dioxide treatment[52] was to give the iron a supercooled graphite structure. The test blocks were cast at successively lower temperatures, which were approximately 1,450, 1,375, 1,300 and 1,250 deg. C. Chemical analysis of the block poured at the lowest temperature gave the following figures:—Mn, 0.54; S, 0.045; and Ti, 0.52 per cent. It is seen that there is ample manganese to balance the sulphur in this analysis, when the formula Mn per cent. = (S per cent. × 1.7 + 0.3) is used, yet microscopical examination revealed the complete absence of manganese sulphide; the only inclusions present were titanium sulphide and titanium carbide. There are two possible reasons which should be considered in trying to explain this anomaly:—

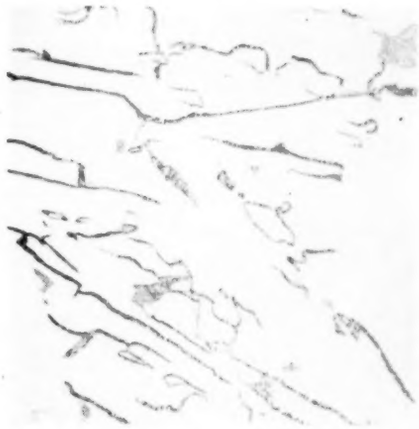


FIG. 46.—GRAPHITE FORMATIONS IN MELT NO. 17. 4-MM. DRY OBJECTIVE. UNETCHED. × 500.

(1) It is probable that the reaction between titanium sulphide and manganese is reversible and can be expressed as follows:—

$$TiS + Mn \rightleftharpoons MnS + Ti$$

This means that with relatively high titanium and low manganese contents, the reaction will proceed towards the left, whereas with relatively low titanium and high manganese contents the reaction will tend to proceed towards the right. Now, in the chemical analysis given above, while there is an excess of manganese over that required to balance

the sulphur, the excess is not great. It should also be noticed that the titanium content of 0.52 per cent. is considerably higher than any encountered in the melts Nos. 2 to 17. These facts should, if the above reversible reaction is assumed, tend to cause the reaction to proceed towards the left, that is, encourage the formation of titanium sulphide.

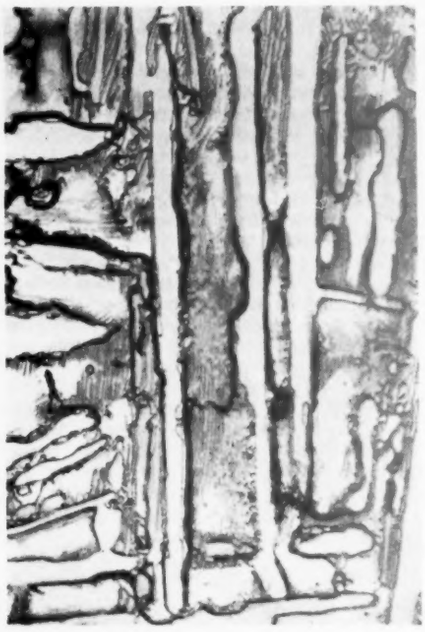


FIG. 47.—FORMATION OF GRAPHITE AROUND CEMENTITE IN MELT NO. 17. 2-MM. OIL-IMMERSION OBJECTIVE. ETCHED IN PICRIC ACID. × 2,000.

FIG. 48.—TYPICAL LAMELLAR TITANIUM SULPHIDE CRYSTAL IN A HOT-POURED 15 PER CENT. SILICON IRON. CRYSTALS OF TITANIUM CARBIDE ON LEFT. 2-MM. OIL-IMMERSION OBJECTIVE. UNETCHED. × 1,200.

FIG. 49.—SMALL COMPACT TITANIUM SULPHIDE CRYSTAL IN COLD-POURED 15 PER CENT. SILICON IRON. 2-MM. OIL-IMMERSION OBJECTIVE. UNETCHED. × 1,200.

(2) The sample in question is abnormal in the sense that it is a 15 per cent. silicon iron, and it is just possible that high silicon contents tend to alter the relationships between manganese, sulphur and titanium.

At the present time it is impossible to tell which of these factors was the cause of the occurrence of titanium sulphide.

In these samples it was possible to observe the effect of pouring temperature on the morphology of the titanium sulphide crystals. The sample poured at the highest temperature had typically lamellar idiomorphic crystals (Fig. 48) and the cold-poured sample had much smaller and very compact crystals (Fig. 49). There were many more crystals of the sulphide in the cold-poured sample than in the hot-poured one. In order to determine this definitely, the samples were examined at a magnification of 1,500, the image being projected on to a ground-glass screen (the area visible in this way is referred to as a unit field), and the number of inclusions per unit field was counted as the specimen was slowly moved under the objective. Two hundred unit fields were counted and the average numbers of inclusions per unit field were calculated for both the hot- and the cold-poured sample, giving a value of 0.074 for the former and 0.470 for the latter. These results still further support the view that the idiomorphic titanium sulphide is a primary form which is precipitated from the liquid iron, since Norbury[52] has clearly demonstrated that primary dendrites in cast iron become smaller and more numerous with decreasing pouring temperature.

(To be continued.)

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[51] Wells: Trans. Am. Soc. for Metals, 1938, vol. 26, p. 289.
[52] Norbury and Morgan: Journ. Iron and Steel Inst., 1936, No. II, p. 327P.

Alkali Desulphurisation

A large-scale practical investigation into the use of alkali for external desulphurisation of hot metal has just been undertaken at the Monessen, Pa., plant of the Pittsburgh Steel Company, states "Steel." Work is being sponsored by the committee on blast furnace and raw materials, iron and steel division, American Institute of Mining and Metallurgical Engineers. A month to six weeks will be required to complete tests. The first two weeks will be devoted to observation of normal practice at the Monessen plant, with data assembled on hot metal, slag, waste gas, yields, limestone, air blast, furnace and ladle linings. Following these observations, work will be changed over to "lean slag" practice by gradually taking off limestone until the slag is so lean that the sulphur in the iron will run about 0.08 per cent., assuming that in normal practice the sulphur runs about 0.035 per cent. or under. The silicon probably will be kept about the same, although it may later be deemed advisable, it is said, to increase the silicon as well as the sulphur for part of the run, and make the same set of observations as under normal and lean slag practice.

It is also proposed in order to evaluate certain alkalis, mixtures and additions, to make observations in connection with the forms of alkali, auxiliary additions to alkali, and application of alkali and mixing; also to study the effect of furnace variables upon efficiency, the disposition and effects of alkali slags, alkali fume and refractories. Observations will also be made at open-hearth furnaces and blooming mill to determine the effects of desulphurised hot metal on time, tonnage, quality and ultimate costs, taking care that steelworks conditions are comparable before and during the trial.

It is the belief in some quarters that the experiment will develop a practice which will provide increased tonnage at lower cost, and of lower sulphur content. Considerable time probably will be required to collect the data.

(Continued from next column.)

foreman, D. Timmins & Son, Fishponds; H. Wash, metallurgical chemist, Lake & Elliot, Limited, Braintree; W. Webb, B.Sc., foundry assistant, English Steel Corporation, Limited, Sheffield.

As Associates

G. Lindley, metallurgical apprentice, English Electric Company, Limited, Bradford; T. Taylor, moulder, Craven Bros (Manchester), Limited.

Institute Elects New Members

At a Council meeting of the Institute of British Foundrymen in Derby last month, the following were elected to the various grades of membership:—

As Members

J. H. Bingley, foundry manager, Harrison & Company (Lincoln); P. S. Davenport, foundry superintendent, Butterley Company, Limited, Derby; J. J. Hall, foundry superintendent, Manganese Bronze & Brass Company, Limited, London; C. A. Honen, general manager, D. H. Diecasting Company, Slough; E. Jones, research engineer, English Electric Company, Limited, Bradford; W. S. Liddell, core-shop manager, Qualcast, Limited, Derby; M. M. Loubser, representative of South African Railways and Harbours in place of W. A. J. Day; J. Maxwell, manager, Wm. Jacks & Company, Limited, Glasgow; C. A. Payne, B.Sc., metallurgist, Qualcast, Limited, Derby; F. W. Rowe, B.Sc., now representative of David Brown & Sons (Hudd.), Limited, in place of Mr. David Brown; R. F. St. B. Wayne, managing director, East Dereham Foundry, Limited, East Dereham; R. A. Webster, Sedgeley, Staffs.

As Associate Members

A. Allen, chief castings inspector, C. & J. Hampton, Limited, Sheffield; B. S. Billimoria, engineering student, Craven Bros. (Manchester), Limited, Reddish; F. Blow, moulder, F. Brown, foundry foreman, and F. H. Brown, foreman annealer, all of Harrison & Company (Lincoln); J. V. Chatterton, metallurgist, at present with H.M. Forces; J. T. Downs, foreman moulder, Craven Bros. (Manchester), Limited, Reddish; H. Doughty, mechanical engineer, Flint & Epton, Johannesburg, S.A.; H. Evans, moulder, Metropolitan-Vickers Electrical Company, Limited, Manchester; N. Grant, foreman patternmaker, Daniel Adamson & Company, Limited, Dukinfield; T. A. Greig, foundry representative, J. & G. Grant, Johannesburg, S.A.; H. W. Griffiths, metallurgical and research worker, English Electric Company, Limited, Bradford; W. Gunnell, foreman patternmaker, John Ruscoe & Company, Limited, Hyde, Ches.; F. Hallas, foundry apprentice, Huddersfield; H. Hardy, foreman coremaker, Harrison & Company (Lincoln); R. J. Hart, chief inspector, Lake & Elliot, Limited, Braintree; W. Hird, foreman moulder, Hepworth & Grandage, Limited, Bradford; T. Hunt, foreman, inspection department, and S. Ironmonger, moulder, both of Harrison & Company (Lincoln); H. Kirkland, assistant foreman, Ley's Malleable Castings Company, Limited, Derby; J. Lewins, metallurgical chemist, Harrison & Company (Lincoln); J. McPheat, chemist, G. & J. Weir, Limited, Glasgow; O. Marshall, foreman engineer, English Electric Company, Limited, Bradford; A. E. Needham, laboratory assistant, Harrison & Company (Lincoln); C. H. Pattman, metallurgist, Serck Radiators, Limited, Birmingham; T. W. Ruffle, analytical chemist, and L. W. Sanders, metallurgical chemist, both of Lake & Elliot, Limited, Braintree; G. H. Scott, foundry foreman, Harrison & Company (Lincoln); H. K. Shaw, patternmaker, David Brown & Sons (Hudd.), Limited; C. H. Smith, Harrison & Company (Lincoln); D. Smith, foreman, Clyde Alloy Steel Company, Limited, Motherwell; C. W. Stacey, foundry foreman, Metropolitan-Vickers Electrical Company, Limited, Manchester; J. Stanton, assistant steel-foundry foreman, Metal Steel Factory, Bengal, India; A. Steele, assistant foundry foreman, Metropolitan-Vickers Electrical Company, Manchester; T. F. Stewart, iron moulder, W. H. Dean & Son, Limited, Whalley; F. V. Thomas, analytical chemist, Lake & Elliot, Limited, Braintree; D. Timmins, foundry

(Continued at foot of previous column.)

Brass Die-Casting

DIE PRACTICE AND OPERATING TECHNIQUE

The die-casting of brass by the Los Angeles Die Casting Company is described by MR. HERBERT CHASE in a recent issue of "The Iron Age." Brass die-castings produced in this plant, said to be the first to make this type of casting on the Pacific Coast, are made in three vertical plunger machines of original design. These machines, the author states, are of the cold chamber type, in which molten or semi-molten metal is ladled into the chamber before it is forced into the die by a hydraulically operated plunger. They are capable of applying to the metal pressures of 13 tons per sq. in. This pressure ensures dense castings, and the machines are capable of averaging around 1,200 shots per 8-hr. day. The same machines are being used for some aluminium die-castings, but die-castings in zinc alloy, made in much the largest volume in this as in most die-casting plants, are produced on another type of machine.

Composite Die Construction

Success in the production of brass die-castings depends in part upon the use of dies capable of resisting for a reasonable period the rather high temperatures at which the metal must be cast without heat checking excessively. To date, this plant has used an imported alloy steel of which it has a considerable supply on hand. The quantity of this steel, which is quite high in cost, used per die is kept as low as possible by forming only the cavity blocks from it and then fitting them into cast-iron or other low-cost chases with which the metal cast does not come in contact. Die cavities usually require repolishing after 3,000 to 4,000 shots if a die-casting having a truly smooth finish is required, but allowances are made for this, and customers are informed when the die is made that some dimensional changes in castings may be expected, because of the polishing, when it becomes necessary.

It is considered feasible to make a die, that is, to justify the required investment, even when as few as 1,000 castings per run are required, provided some three or four repeat orders a year are anticipated. In some cases, there are possible economies in even shorter runs, since, as indicated later, the savings over other methods of production usually are considerable. As compared with sand castings, the brass die-casting can often be made much lighter or of about double the strength for a given section thickness, hence there are economies in metal as well as marked savings in machining costs.

Some Examples of Die-Cast Brass

Fairly typical of what has been done is a valve body having a section thickness in most parts of from $\frac{1}{16}$ to $\frac{3}{32}$ in. There are cores at both ends and at the back, and the casting weighs about 5 ozs., as against 12 ozs. for the sand casting formerly used. Although the price per casting is the same as for the sand casting, the latter required so much machine work that the net cost of the finished piece is about 50 per cent. lower in the die-casting, which also is very smooth and is very attractive when plated. Along the front of this casting there is a cored recess, only a few thousandths of an inch deep, for a stripe of coloured paint, which also improves the appearance. Although this piece requires a die with two hydraulic core pulls, the die cost was held below £45.

A bushing now die-cast in red brass was formerly made as a forging, with a hexagon on the smaller of the two outer diameters. The change to the die-casting was made because the hole, which is later tapped with a 24-pitch thread, could be held within closer dimensions, namely, ± 0.003 in. of the size desired.

Even on parts usually made on the screw machine, partly because all surfaces are surfaces of rotation, the brass die-casting can sometimes show a saving, as in a bushing which has two outside and two inside diameters. In one case, the maximum O.D. was 1½ in. and the minimum I.D. 1 in. This bushing, as delivered by the die-caster, weighs less than 2 ozs., but when turned from brass rod it took 8½ ozs. gross metal per piece. Sale of scrap paid the cost of machine work only on the part produced by the screw machine, but metal cost alone ran the cost of the piece to the customer to nearly double the cost of the die-casting. This bushing was die-cast in a low-cost, three-cavity die, run at 1,200 to 1,400 shots per 8 hrs., or a total of about 4,000 bushings a day.

Bath-Room Fittings

Flat parts, such as combination tumbler and tooth-brush holders, are readily die-cast with the holes cored to size and with a finish so smooth that a minimum of polishing is needed to prepare them for plating. If forged, the holes would be difficult if not impossible to form without machining, and a sand casting would be less accurate as to size and require more work in polishing than the die-casting; hence the latter is chosen and proves its utility.

The use of inserts is entirely feasible in making brass die-castings, as is illustrated by the cranked handle part of a soap dispenser. In this case, the insert is a steel rod and, despite the time required to place the insert in the die, the casting is produced at the rate of about 1,200 per 8-hr. day.

Caps with wings to assist unscrewing are sometimes cast in sand, but coring lacks the accuracy obtained with the part of this type made in die-cast form. In a cap used as part of a spray gun, the angles formed by the end of the core are important, and separate cores with various angles are used for different lots of castings. A two-cavity die for this part costs well under £40, and the caps produced in it materially lower the customer's machining costs as compared with a sand-cast cap, besides being much stronger.

Door Knobs

A door knob carrying a recess for a tumbler lock is readily die-cast in brass. An alloy containing 62 per cent. copper and the balance zinc is used for all parts so far mentioned, except the red-brass bushing. In such a knob the tubular extension is made in a screw machine and used as an insert, although it could be cast integral. If so cast, however, it would be necessary to use a rather long and quite slender core. This is preferably avoided in brass die-casting, since the pull required is long and a slender core pin may be bent and require frequent replacement. By using the insert, the pin merely positions the latter in the die and is protected from bending by the insert itself, which is inexpensive. The remainder of the casting, formed by the die to the irregular shape, shrinks tightly on to the insert, which is necked so that it cannot pull out. A part such as this could not be produced complete on the screw machine or, even if it could be, would involve a large waste of metal. If sand cast, much machining would be needed and the cored interior would lack the accuracy attained in the die-casting, which requires very little machining.

Four-Spoke Handle

Valve and faucet handles are among the parts being die-cast in brass with a finish and strength much superior to sand castings. Some of these castings have a hexagon cored in the hub portion and held within dimensional limits so close that no machining is needed, a condition not fulfilled in a sand casting.

In many cases, and especially in those where the die-casting is thought to have possibilities, these may well be investigated along with other alternatives, and that which gives the most favourable all-round results selected. Die-castings in zinc and aluminium alloys are cheaper than those in brass, but each form has its own peculiar advantages which can be quickly pointed out by a company equipped to make all these types. Brass die-castings rank very high in strength and possess a marked degree of corrosion resistance.

Hydrogen Embrittlement of Copper

Addressing members of the American Institute of Mining and Metallurgical Engineers on the subject of "Hydrogen Embrittlement of Pure Copper and of Dilute Copper Alloys by Alternate Oxidation and Reduction," FREDERICK N. RHINES and WILLIAM A. ANDERSON summed up the new results obtained in their study as follows:—(1) It has been demonstrated that very pure copper can be made susceptible to hydrogen embrittlement by saturating it with oxygen. Embrittlement follows whether the oxygen is held in solid solution or is allowed to precipitate as cuprous oxide. (2) It has been demonstrated further that foreign oxides embedded in copper are reduced by hydrogen at elevated temperatures and that a type of hydrogen embrittlement can result from this cause alone. (3) The oxides known to be reduced in hydrogen, such as those of indium, manganese, nickel, phosphorus, tin and zinc, produce the most severe embrittlement, while the oxides of niobium, gallium, lithium, magnesium and zirconium are only slightly effective; intermediate in their effect are the oxides of aluminium, arsenic, beryllium, bismuth, boron, calcium, cerium, cobalt, chromium, iron, lead, antimony and titanium. (4) A type of embrittlement less severe than hydrogen embrittlement is caused by the presence of a subscale on copper alloys. Subscales in which the oxide precipitate is heaviest or most concentrated at the grain boundaries are most damaging. (5) Copper alloys containing small quantities of arsenic, antimony or bismuth were embrittled by annealing in hydrogen without previous oxidation. It is suggested that volatile hydrides such as arsine, stibine or bismuthine may have formed under sufficient pressure to cause the rupture of the alloy.

Publication Received

Index to A.S.T.M. Standards. Issued by the American Society for Testing Materials, 260, South Broad Street, Philadelphia, Pa.

This index, which also includes tentative standards, gives information on the 952 specifications which were in force on December 1, 1940. It is of real use to those who desire to ascertain whether the Society has issued standard specifications, test methods or definitions covering a particular engineering material or subject, and is of help in finding the standards in the volume where they appear.

The cross-indexing has been exceptionally well carried out, which fact can be illustrated by reference to cast iron, for under this heading are listed not only grey iron castings *per se*, but also foundry pig-iron, methods of chemical and micrographical analysis, the various malleable specifications, and so forth. The booklet, which runs to 172 pages, is available to our readers free of charge from the Society.

Relation of Defects in Enamel Coatings to Hydrogen in Steel

By C. A. ZAPFFE and C. E. SIMS

(*Continued from page* 12.)

A plate of pure graphite was enamelled in the present research in an attempt to find the extent of carbon-enamel reactivity. Firing a blue ground coat did not result in blistering. The bar was given a heavy, uneven second coating on one end and fired again, but still no blistering occurred (Fig. 29). Of course, the porosity of the graphite may have prevented the development of sufficient pressure to form blisters, but a surprisingly solid coating was obtained, and there was no noticeable boiling action during firing.

The strong attraction of pearlite for hydrogen, even in the absence of porosity, is shown by the following experiment. Two customary plates, without holes, were carburised by heating with carburising compound at 950 deg. C. for 15 hrs., thereby obtaining a high-carbon case approximately 0.03 in. thick. This case was completely ground away except for the rim and two rectangular areas across the width of the plate (Fig. 30). One plate was sand-blasted, and the other received the usual pickling treatment. Both plates were given an extended baking period to ensure removal of all ordinarily dissolved hydrogen and were then fired with blue ground coat at 870 deg. C. The results are shown in Fig. 30.

FIG. 29.—BLUE GROUND COAT FIRED ON PIECE OF GRAPHITE. LEFT: LIGHT APPLICATION. RIGHT: UNEVEN HEAVY APPLICATION.

An interesting observation during firing was that a tiny brilliant spark marked the combustion of the bubble-forming gas as each blister ruptured. These minute bursts of flame occurred over the bubbles on both specimens, though less frequently on the sand-blasted specimen. The gas was not analysed, but both CO and H_2 burn with blue flames. Methane, however, burns with a luminescent flame, and the firing temperature is well within the range in which hydrogen decarburises steel. This observation tends to strengthen the argument that boiling is largely due to hydrogen and also suggests that the decarburisation, often noted in surface layers of the steel, is due to hydrogen rather than to oxygen.

Hydrogen released into steel by destruction of the C-H bond is illustrated in another test.

FIG. 30.—CARBURISED RIDGES ON STEEL PLATES FIRED WITH BLUE GROUND COAT. UPPER: SAND-BLASTED. LOWER: PICKLED.

The pickled specimen has ostensibly boiled much more violently than the sand-blasted specimen. The *débris* belongs to the pickled plate, most of the chips having come from the sides where the rim is also carbon-rich. It must be recognised that substitution of sand-blasting for pickling does not preclude the presence of hydrogen in the sand-blasted specimen. A considerable quantity of hydrogen can be absorbed from the reducing gases in the furnace atmosphere and from miscellaneous moisture associated with carburising, so that a comparison of boiling due to hydrogen in these two specimens can only be one of degree. Correspondingly, it is evident that the specimen prepared by sand-blasting has boiled to some extent. Microsections through the carburised ridge of the badly blistered, pickled specimen are shown in Fig. 31. Note the relatively high carbon content of the steel that was used in the present research. A similar test discussed later in regard to fishscaling develops the same evidence.

The three holes in a customary plate were carefully cleaned with distilled water and acetone, and traces of hydrocarbon were removed by firing. A very thin film of ordinary machine oil was brushed only into the two end holes with a pipe cleaner. The three holes were sealed and welded as before, and the plates were prepared for enamelling by sand-blasting. Fired with both ground and cover coats, the plate is shown in Fig. 32. The film of oil in the two end holes has decomposed during the heating to release hydrogen and carbon to the steel. As the carbon could not have possibly diffused to the surface during the brief firing period, it can only be concluded that hydrogen, which diffuses much more rapidly than carbon in steel, has caused both primary boiling and reboiling ("blistering in the cover coat") in this specimen. The experiment may serve to explain the observation that a paint mark on enamelling sheet will cause reboiling on the opposite side.

FISHSCALING

Introduction

"Fishscaling" has been discussed at great length in the enamelling literature. As nearly 100 articles have appeared on the subject of fishscales, it is unnecessary to define the defect or to discuss its appearance. In America, the accepted explanation given for fishscaling is that the defect is due to mechanical stresses inaugurated by differences in the coefficients of expansion between the enamel and the steel. Elsewhere, however, some investigators have recognised that fishscaling is caused by the effusion of hydrogen from the steel. Hydrogen at one time or another as a cause of fishscaling has been suggested by American writers, but

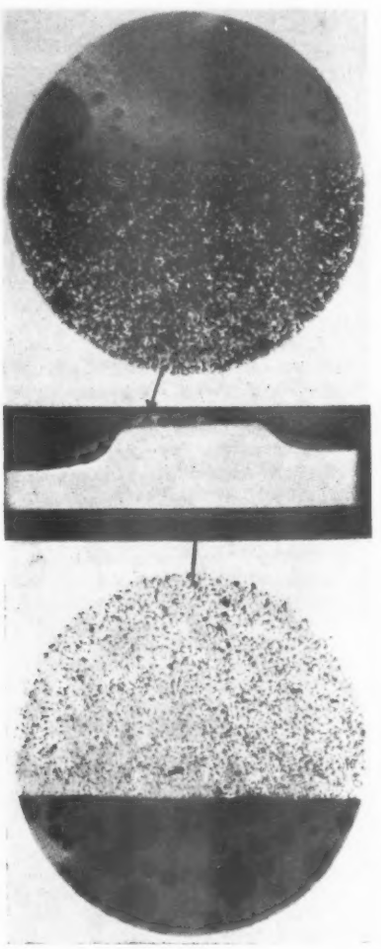

FIG. 31.—MICROSECTIONS THROUGH CARBURISED RIDGE OF SAND-BLASTED SPECIMEN IN FIG. 30. TOP AND BOTTOM, × 150. CENTRE, × 2.

the functions of this gas in steel were almost completely unknown, and all of the suggestions have been discarded. Sweely, in 1922, and Andrews, in 1931, performed the identical type of experiment shown in Fig. 9 of the present work without noting that the enamel chips that exploded off the other side of the acid-treated

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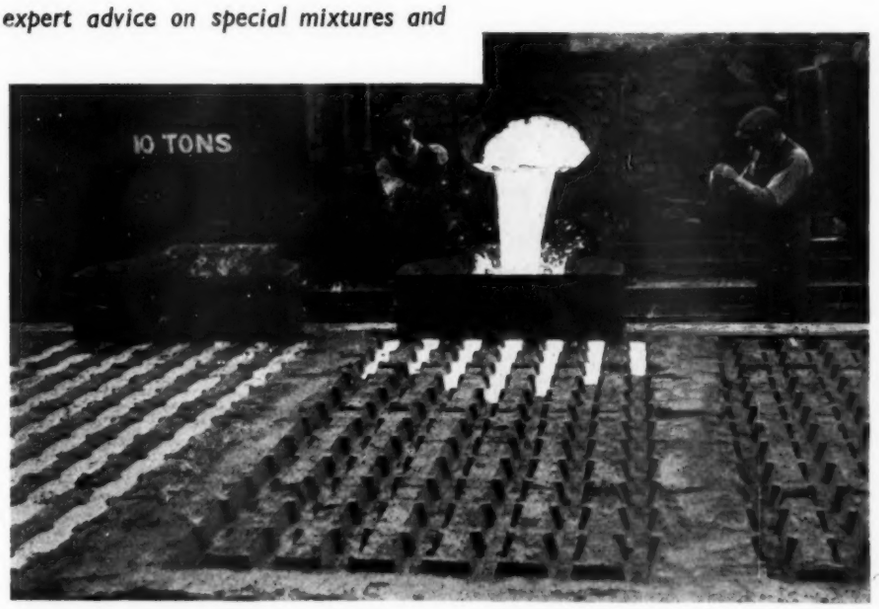

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steel were due to hydrogen. Sweely briefly considered hydrogen, but chose mechanical stress instead as the cause of the chipping; and Andrews suggested that mechanical stresses were inaugurated or became unbalanced by corrosion of the metal in the acid. Shaw, in 1920, suggested that fishscaling was caused by gas that collected under the enamel, and porous enamels that will allow gases to escape during firing have been suggested.

As with blistering and boiling, it has been observed that reducing gases in the furnace atmosphere and overpickling lead to fishscaling, that fishscales are related to defects in the steel, that slow cooling will prevent fishscaling, that the defect is common over weld metal, and that the thicker the "hazy layer" of iron oxide the greater is the tendency to fishscale. The fact that heavy-gauge stock fishscales more than light conforms perfectly with the hydrogen theory, but has provided circumstantial and misleading evidence in favour of the mechanical stress theory. Schaal and Fuller state that gas evolves from the metal, and they believe that primary boiling, copperheading, fishscaling and reboiling are all directly related. Again, they

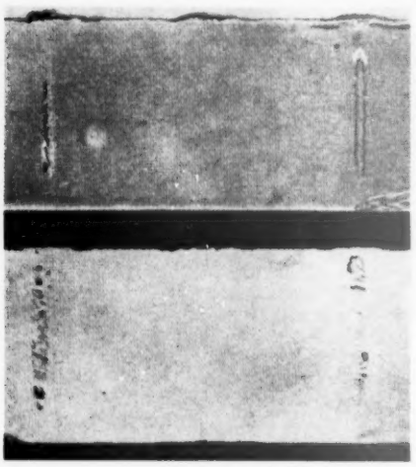


FIG. 32.—GROUND COAT (UPPER) AND COVER COAT (LOWER) FIRED ON SAND-BLASTED PLATE. THE TWO END HOLES CONTAINED THIN OIL FILM WHICH RELEASED HYDROGEN ON FIRING. CENTRE HOLE WAS EMPTY.

show that fishscales are situated over ground coat that has been made spongy by gas evolution during firing. Lastly, studies of expansion coefficients have been unenlightening, for there is very little difference between the coefficients for ground-coat enamels and for steel except at the transformation temperature of the steel, and then the enamel is viscous and will not support stress.

Vielhaber, in 1930, was apparently the first to suggest that hydrogen was responsible for fishscaling. Two years later he reported doing the enamelled-pan experiment (Fig. 9, present research), and recognised that the chipping and scaling were due to hydrogen that had diffused through the steel from the acid reaction on the other side. To give the gas a chance to escape and thereby to prevent fishscaling, Vielhaber suggested that the piece be slowly fired or that a mill addition be made that would extend the range of fusibility of the enamel. Leon and Slattenscheck pointed out that hydrogen in roll blisters (refer to Fig. 4) and in slag inclusions would tend to warp the steel and thereby to cause stress in the enamel.

Hoff and Klärding dried enamel slip for ten hours at 110 to 135 deg. C., and found that nearly 1 per cent. of moisture remained. They then proved by direct experiment that this chemically-held moisture breaks down during firing to form principally hydrogen, with some carbon dioxide from the carbon in the steel. The hydrogen diffuses into the metal and acts, as already described in this writing, to cause reboiling and fishscaling. These investigators then placed specimens showing fishscaling in a closed flask, and over a period of two weeks collected one cubic centimetre of gas that analysed nearly pure hydrogen.

Kerstan examined half-a-dozen different types of enamelling stocks, ranging from pure iron to copper-bearing steel, and found that each type varies considerably in initial hydrogen content and that each shows a marked increase in hydrogen content after the first firing. For example, one sheet analysed: As received H_2 = 0.00022 weight per cent.; after firing H_2 = 0.00098 weight per cent., and, in two hours after firing, fishscaling began. Kerstan then took stock that showed much fishscaling and fired it with ground coat that contained ethyl alcohol

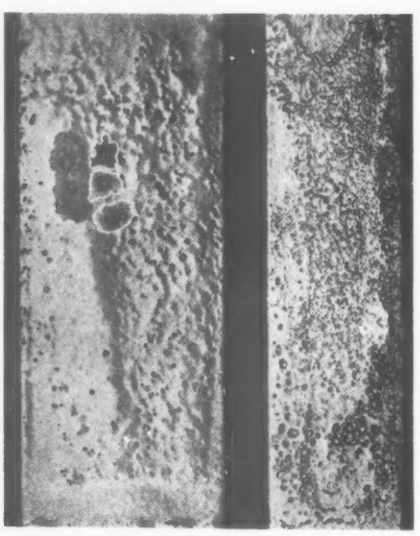


FIG. 33.—HEAVY STEEL BAR ENAMELLED IN STANDARD MANNER, BAKED 20 MIN. AT 115 DEG. C., AND FIRED WITH UNEVEN APPLICATION OF BLUE GROUND COAT, SHOWING BLISTERING AND FISHSCALING CAUSED BY HYDROGEN ABSORBED DURING PICKLING. LEFT: FRONT VIEW. RIGHT: SIDE VIEW.

instead of water in the slip and quince-seed extract instead of clay. No fishscales appeared in twenty days. Kerstan went on to show that the tiny "crystallites" or "shiners," which have often been considered a separate defect, are merely minute fishscales. His interpretation of the effect of underfiring on fishscaling, which has been so frequently noted, may be criticised, however, for he suggests that the lack of diffusion of iron oxide into the enamel causes a concentration gradient that in turn causes mechanical stress from expansion differences. A better reason may be that good adherence is not fully developed during insufficient firing and less hydrogen pressure is therefore necessary to cause scaling. Hansen and Irwin have suggested increasing adherence to minimise fishscaling.

It is difficult to picture the extremely localised fractures that are fishscales to be results of the general mechanical stress that would be provided by expansion differences between the coatings and the metal. The enamel coating on the graphite plate (Fig. 29) cracked during cooling, but there was no evidence of anything that resembled a fishscale.

Relation of Blistering and Boiling to Fishscaling

The following research has been designed to find out if hydrogen is the cause of fishscaling and to demonstrate the mechanism of fishscaling by experiment. First, the relation between blistering and boiling in the soft enamel and fishscaling in the hardened enamel will be shown. The relation should be obvious, for if hydrogen effuses at high temperatures to cause blistering it must certainly effuse at lower temperatures when the solubility of hydrogen in steel so sharply decreases. This does not imply, of course, that all steels that boil or reboil will fishscale, because complexities in the steel-hydrogen system and permeability and adherence of the enamel may act to suppress the formation under the enamel coating of the critical aerostatic pressure necessary to cause fishscaling.

To demonstrate the relation between blistering and fishscaling, a heavy section of plain carbon steel, 1 by 1½ by 5 in., was prepared in the standard manner, dried 20 mins. at 115 deg. C. and fired with an uneven application of blue ground coat. For so thick a section, 20 mins. at 115 deg. C. is plainly insufficient for the removal of the hydrogen absorbed during the pickling. In fact, the increased rate of diffusion that occurs at 115 deg. C. actually operates to drive hydrogen into the steel as well

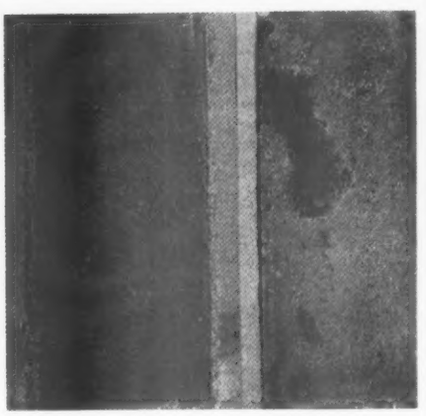


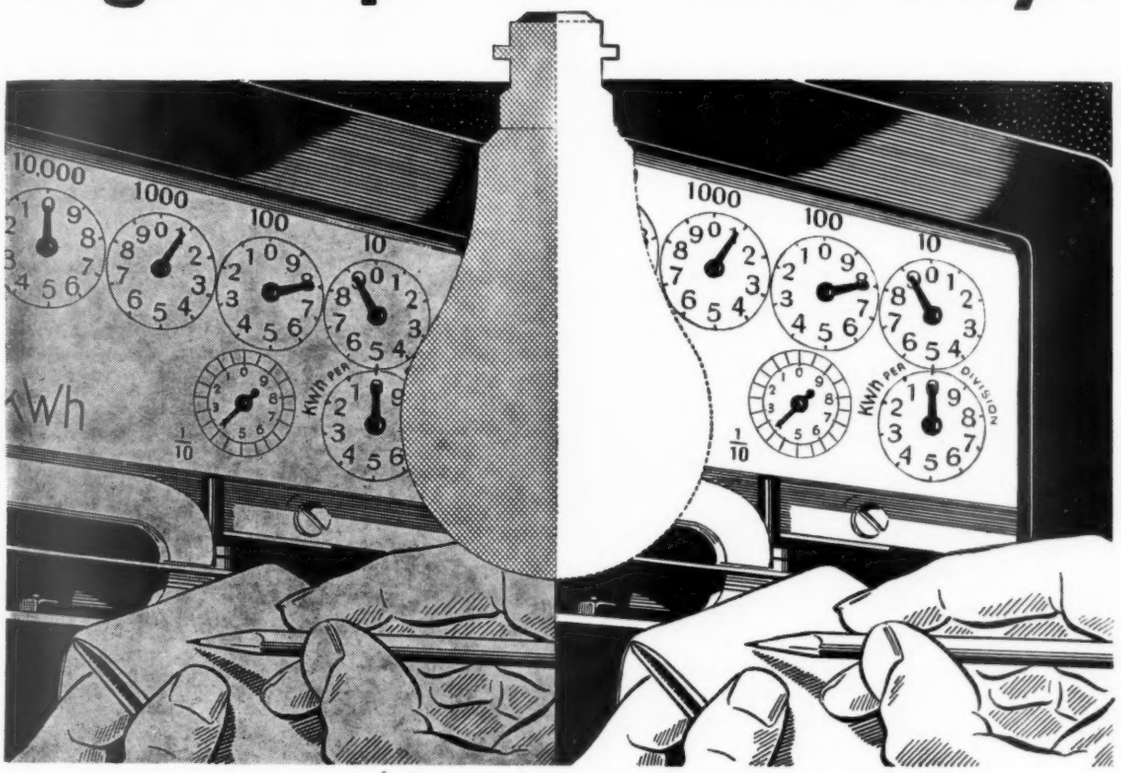
FIG. 34 (LEFT).—SPECIMEN AS IN FIG. 33 PLACED IN PREVIOUSLY-BOILED WATER AT 95 DEG. C. 2 DAYS AFTER FIRING. NOTE LOCATION OF BUBBLES.

FIG. 35 (RIGHT).—SAME SPECIMEN AFTER IMMERSION IN WATER FOR 2 HRS. AT 95 DEG. C.

as out of it. During firing, as would then be expected, the coating blistered badly (see Fig. 33). It is interesting to note that the side blistered much more severely than the face, for it has been pointed out that hydrogen dissolved in steel diffuses interstitially through the iron lattice and that impurities or discontinuities hinder this diffusion by trapping the gas as molecules or by retaining it by forces of a chemical nature. Therefore, the rolling, or banded, structure of steel sheet and plate should show directional properties in regard to hydrogen diffusion that should become stronger with increasing content of impurity or increased banding. This is why the specimen in Fig. 33 shows greater blistering on the side than on the face, for the piece contains about 0.18 per cent. of carbon and has been rolled parallel to the face. The phenomenon also explains why so much trouble is encountered in "black-edging," where heavy applications of enamel are applied on the sheared edges of heavily rolled sheet, and why it is difficult, even with thin sheets, to bake out dissolved hydrogen.

On the face of the specimen in Fig. 33 are shown three "fishscales," "chips," "pop-offs," or whatever one may wish to call them. These pieces left the coating shortly after cooling with an explosive violence that has been observed by many investigators and has been demonstrated

Light up—for economy!



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artificially in the first part of the present Paper (Fig. 9). Such an explosive reaction suggests gas pressure rather than mechanical stress, especially when it is seen that the chips overlie large blisters that were caused by gas effusion themselves. It is also significant that the chipping has preferred the thick glazed seam of enamel, for much has been written showing that thicker coatings are more amenable to the defect. Increasing the thickness of the coating obviously decreases the chance for the hydrogen to escape and thereby to form the collection of gas under pressure.

To illustrate the reactions that have been postulated herein, the bar was placed in previously boiled water at 95 deg. C. two days after firing. In about a minute, bubbles had formed as shown in Fig. 34, and they continued to form as long as the specimen was immersed.

There are several important features to note in Fig. 34. First, many of the gas bubbles appear exactly at centres where blisters had risen in the enamel during firing two days before. (Several large bubbles left the scaled area just before this photograph was taken.) Reboiling is characterised by a tendency of the blistering to recur at the same loci, and the concurrence of bubbles and blisters here gives additional proof that most of the blistering during firing was not caused by carbon oxides, in spite of the fact that the steel contained much more carbon than does enamelling stock. Secondly, there are no gas bubbles on the surface of the thick, glazed seam. As the effusion is otherwise quite general over the whole specimen, it is logical to assume that hydrogen is being liberated under this seam, but that the thickness of the layer prevents its escape. In a short period of time, nearly the whole seam was blown away by the accumulating hydrogen, thereby justifying this assumption. Lastly, the bubbles are much more numerous on the sides than on the faces, concurring with the observations just noted on blistering and on hydrogen diffusion. Fig. 35 shows the same specimen after two hours of immersion. Scaling has been greatly accelerated proportionately with the great acceleration in diffusion of hydrogen that occurs when the temperature is increased to 95 deg. C. The glazed portion of the thick seam has been exploded away by hydrogen, revealing badly blistered enamel. Some unusual scaling, resembling "eyes," has also occurred at points of gas evolution where the earlier enamel blister had sealed over with a thin glazed layer.

FIG. 36.—FISHSCALE IN COVER COAT DIRECTLY OVERLYING BLISTERS IN GROUND COAT.

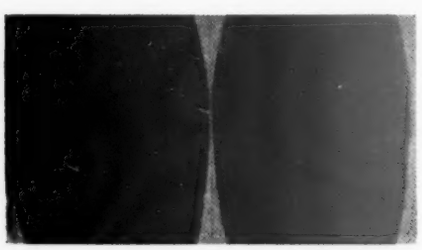

FIG. 38.—LEFT, FISHSCALES ON COMPOUNDED DISC 6 WEEKS AFTER FIRING WITH BLUE GROUND COAT. RIGHT, SAME DISC AFTER HEATING 5 MIN. AT 200 DEG. C.

Fishscaling in cover coats is less frequent than in ground coats, which difference may be explained as due to differences in refractoriness, in permeability to hydrogen of the two coats, and to the reduced quantity of hydrogen that is likely to be present in subsequent firings. It has been explained that hydrogen is quite rapidly lost during repeated firings and that, after the first firing, hydrogen will not be so quickly replenished by iron-moisture reactions because the first coating tends to protect the metal. Nevertheless, hydrogen can cause chipping and scaling in cover coats, too, as is shown in Fig. 36. Here the scale has overlain obvious blisters in the ground coat and therefore subscribes to the same reasoning used for the previous thick seam of ground coat. The confusing observations in the literature indicating that fishscales originate at various depths in the enamel may be explained simply as due to the various layers in the enamel to which the gas must diffuse before being hindered sufficiently to develop pressure. In the particular case shown in Fig. 36, most of the ground coat remained on the steel.

Hydrogen retained in steel by carbon can also be released during temperature changes to produce fishscaling just as it does blistering. An interesting example is shown in Fig. 37. A customary steel plate, without holes, was electrolytically copper-plated and machined diagonally on one side as shown in Fig. 37 (left). The plate was then carburised at 950 deg. C. for 15 hours. The copper was removed with nitric acid, and a plate remained that was uniformly low in carbon content except for an indented diagonal area on one side where carburisation had proceeded to a depth of about 0.03 in. The plate was prepared with the standard enamelling procedure, sprayed with blue ground coat, and baked at 115 deg. C. for 30 minutes. This baking period sufficed to remove ordinary dissolved hydrogen because no blistering occurred on the front, low-carbon face during firing. Blistering did occur over the carburised area on the back face, but the following evidence, as well as that cited previously, indicates that even the blistering there was not due to carbon so much as to hydrogen that had become associated with the carbon during pickling. Two days after firing, fishscales began to appear on the front, low-carbon face first, over areas corresponding quite well to the high-carbon diagonal on the opposite side of the plate, but later over the whole face (see Fig. 37 (right)). Thus, during firing, hydrogen had been liberated from the carbon immediately to cause blistering on the back face over the carburised area; it also diffused later into the steel from deeper-seated portions of the carbon-rich region to cause fishscaling. In the short firing period, the hydrogen could not diffuse through to the opposite face, but it did arrive there two days later to cause fishscaling.

Another layer of ground coat was then applied, and, during baking at 115 deg. C., the hydrogen effusion on the low-carbon side of the plate became so severe that *scales of the baked slip were exploded off the specimen* (see Fig. 37 (middle)); it is again noteworthy that these "slip scales" in most cases have occurred exactly over the underlying fishscales. The steel is actually visible under several of the "double scales." The specimen was fired regardless of the damaged slip, and the second coat continued to fishscale as shown in Fig. 37 (right). Here again many fishscales have formed on the sites of former scales.

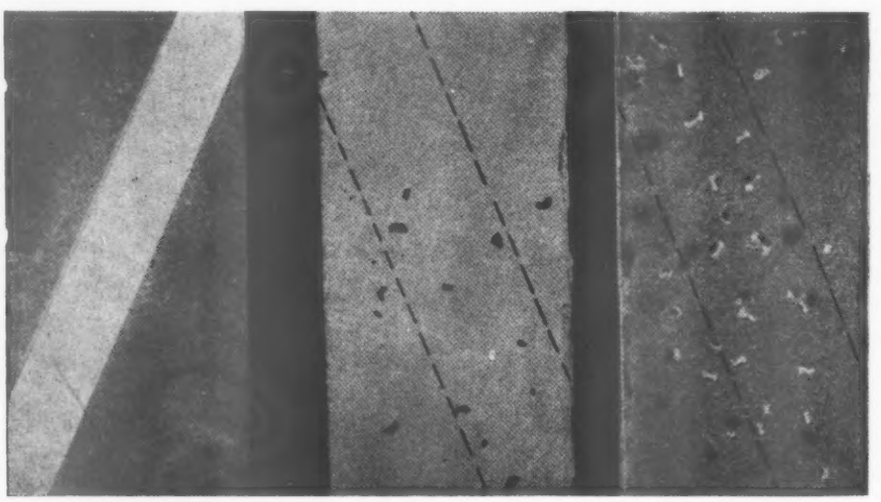

FIG. 37.—LEFT, CARBURISED DIAGONAL AREA ON BACK OF COPPER-PLATED STEEL. MIDDLE, BAKED UNFIRED SLIP OF SECOND GROUND COAT ON FRONT OF PLATE. RIGHT, SECOND GROUND COAT AFTER FIRING.

In the same manner, hydrogen may be liberated from occlusion in inclusions or cavities during firing and may reach the surface only after the enamel has cooled. Such a case is illustrated in Fig. 38. Two steel discs cut from a 2-in. bar of plain carbon steel were welded together and rolled just as in the experiment shown in Fig. 10. In that experiment, hydrogen that was absorbed during pickling by the compound disc was trapped at the unwelded portions of the interface and developed sufficient pressure there to blister the steel. In the present experiment, less hydrogen, of course, was absorbed during the shorter pickling time and was therefore insufficient to cause blisters or defacement of the steel. Nevertheless, hydrogen collected there, and this dissolved during firing, though not rapidly enough to appear as blisters in the enamel. In fact, ten days after firing there was still no evidence of hydrogen defects, but soon thereafter a small fishscale appeared. The case is an excellent example of the "delayed" fishscaling that is so troublesome to enamellers and shows how

(*Continued on page* 98.)

Pig for Victory

We have amended the popular slogan because most of the qualities required for victory are inherent in Warner Pig Iron.

Toughness — Resistance to wear and tear—Strength—Uniformity — Reliability — and Economy, to mention but a few.

Admittedly, we can think of no spiritual virtues which Warner Pig Iron can contribute to the winning of this war — although our artist obviously regards it as pig-headed and we can at least hope that this will confirm the worst suspicions of the enemy regarding everything British.

Warner's

Special Pig Irons

WARNER AND CO. LTD., CARGO FLEET, MIDDLESBROUGH

The Week's News in Brief

Trade Talk

AMONG the latest rulings regarding liability to Purchase Tax, it is stated that in Class 7 (Lighting Fittings and Domestic Appliances, etc.) exhaust fans designed for building into the structure of buildings are not chargeable.

EMPLOYEES of Carron Company, Limited, last year subscribed £4,376 to local infirmaries and institutions and to special war charities. Those of L. Sterne & Company, Limited, contributed £177 to Glasgow hospitals and charitable institutions.

TO COMMEMORATE the twenty-first anniversary of the inauguration of Hartley's Malleable Fittings Company, Limited, Halifax, the directors recently entertained the staff and employees to a dinner and social evening at the Grand Junction Hotel, Halifax.

THE Wrought Light Alloys Development Association has now been registered as a public limited company, limited by guarantee. The income and property of the Association shall be applied solely towards the promotion of its objects. The following are members of the Council:—Messrs. P. Pritchard (nominee of Birmetals, Limited), H. W. Clarke (James Booth & Company (1915), Limited, W. C. Devereux (High Duty Alloys, Limited), A. J. G. Smout (I.C.I. Metals, Limited), F. S. Mitman (Northern Aluminium Company, Limited), A. M. Reynolds (Reynolds Tube Company, Limited), and E. A. Reynolds (Reynolds Rolling Mills, Limited).

THE HEATING APPLIANCES AND ACCESSORIES EXPORT GROUP has been recently formed. The manufactures included in this Group are covered by the general classification of "All plant in connection with heating," which includes boilers of all descriptions for low-pressure steam and hot water; mechanical stokers; oil burners and gas-firing apparatus; valves; boiler mountings, etc.; radiators of steel or cast iron; hot-water pipes and connectors; convectors; humidifiers; calorifiers; all systems of automatic temperature control and thermostats; steam traps; unit heaters; and jacketed pans and kettles, etc. The executive committee consists of Mr. Arthur G. Marshall (chairman and secretary—2, Howard Street, Strand, London, W.C.2); Mr. J. E. Bennett (Crane, Limited); Mr. E. A. Bleach (Royles, Limited); Mr. C. H. Clifford (Steel Radiators, Limited); and Major R. W. Jenkins (Robert Jenkins & Company, Limited). The Group is devoting special attention to the South American and Dutch East Indian markets, in addition to those offered by the Dominions and Colonies.

MR. ERNEST BEVIN, Minister of Labour, was assured when he met the T.U.C. General Council and the Council of the British Employers' Confederation last week that so far as voluntary effort could secure the requisite numbers and efficient use of man-power, the Government would have the wholehearted co-operation of the employers and the unions. This assurance was given to Mr. Bevin after various aspects of the proposals had been discussed at a private conference at which Mr. Bevin made it clear that the Government in its plans is relying for the present on a voluntary effort. The Minister stated afterwards that he had issued an appeal to industries to examine carefully their own problems of man-power and production, and any scheme which could be applied, if brought forward quickly, would be given the most careful consideration. The two sides had expressed the view that considerable results could be obtained if the scheme that might be evolved for a number of industries could be dovetailed into the general scheme. The Conference was very anxious to avoid disturbing or undermining the joint industrial machinery that exists in the various industries, and Mr. Bevin readily agreed to use it to the fullest possible extent. All the parties appreciated the problems with which the country was faced.

SIR CECIL M. WEIR, presiding at the annual meeting of Glasgow Chamber of Commerce, said that many industries which had contributed largely in the past to employment and prosperity—and would do so again when the war was over—but were ranked for war purposes amongst the less essential branches of manufacture, merchanting, and distribution, had a big and useful part to play even at the present juncture. In playing that useful part such industries would have to make temporary sacrifices. Production and consumption for ordinary civilian purposes must be limited to what was really necessary, not just because unnecessary spending was undesirable and saving and lending to the State a vital factor in the war effort, but mainly because the call for labour and for factory and storage space was already immense and was rapidly increasing. An industry whose capacity could no longer be fully employed would perform a valuable national service if it would, of its own initiative, take steps by collective action within the industry to concentrate its total production in the minimum number of plants required to produce the permitted and obtainable volume of trade, thus giving an economic load to each of the selected manufacturing units. The alternative in some cases would be confusion, loss of markets, and financial embarrassment. Mutual arrangements would, of course, be necessary to ensure that the benefits would be spread over all the participating firms, and measures would need to be taken to put surplus plant and machinery on a "care and maintenance" basis, so that the healthy structure of the industry might be preserved for immediate and full resumption on the conclusion of hostilities.

Personal

MR. FREDERICK T. VEEVERS, proprietor of Veever's Foundry, Burnley Road, Padiham, from 1901 until 1929, celebrated his 90th birthday on February 4.

SIR CLIVE BAILLIEU, following his appointment as Director-General of the British Purchasing Commission, has resigned his position as chairman of the Imperial Smelting Corporation, Limited, the Zinc Corporation, Limited, and New Broken Hill Consolidated, Limited. Mr. John Govett has been appointed in his place.

SIR ANDREW RAE DUNCAN has been elected as an honorary member of the Institution of Electrical Engineers in recognition of his outstanding services to the electrical engineering industry as chairman of the Central Electricity Board. Dr. A. P. M. Fleming, head of the Metropolitan-Vickers' research activities, is the recipient of the nineteenth award of the Faraday Medal.

Reports and Dividends

William Baird & Company, Limited—Interim dividend of 4 per cent.

Follsain Syndicate, Limited—Loss for 1940 of £1,351, making the total debit £8,287.

Westinghouse Brake & Signal Company, Limited—Profit for the year to September 30, 1940, £159,781; brought in, £90,432; to general reserve, £50,000; staff pensions, £5,000; reserve for contingencies, £25,000; reserve for investments, £13,293; dividend of 10 per cent., £64,536; carried forward, £92,384. Meeting, February 11.

Relation of Defects in Enamel Coatings to Hydrogen in Steel

(*Continued from page* 96.)

deliberately the pressures may increase. At the end of six weeks about two dozen fishscales had appeared (Fig. 38 (left)). The piece was then inserted in an oven at 200 deg. C. and in five minutes the number of fishscales increased to more than 100 (Fig. 38 (right)). The temperature was increased to 250 deg. C., but the scaling had stopped as suddenly as it had begun, indicating that all available hydrogen, probably just that quantity freed from occlusion during firing, had effused from the steel. To prove that mechanical stresses had nothing to do with the defect, the plate was heated rapidly to 250 deg. C. and quenched in water. No additional scales appeared, nor did another scale appear in the succeeding two months.

(*To be continued.*)

Obituary

DR. MILES WALKER, F.R.S., for 20 years professor of electrical engineering in the Faculty of Technology, University of Manchester, died recently, at the age of 73.

MR. KENNETH AIRD, chairman and governing director of R. & A. Main, Limited, the well-known gas-cooker manufacturers of Gothic Works, Edmonton, London, N., has died. He was also chairman of Thomas Glover & Company, Limited, and of the parent company, Glover & Main, Limited.

MR. CHARLES RICHARDS, a member of the British Economic Mission to South America, died at Rio de Janeiro last week. Mr. Richards was joint managing director of the Metropolitan-Vickers Electrical Export Company, Limited. He was drowned while bathing. Mr. Richards was 56 years of age.

PROF. B. P. HAIGH, professor of Applied Mechanics at the Royal Naval College, Greenwich, died recently. Prof. Haigh graduated at Glasgow University and practised engineering abroad, notably in Sweden, for several years. Returning to Bristol University he commenced investigations into the fatigue of metals, on which subject he became an acknowledged authority. In 1913 he took up an appointment as an instructor in applied mechanics at the Royal Naval College. During the war of 1914-18 he, in collaboration with Admiral Burney, made possible the practical application of the paravane. After that he became an expert on welding, particularly with regard to ships. His professorship dated from 1921.

WE REGRET to announce the death of Dr. H. S. Hele-Shaw, D.Eng., D.Sc., LL.D., F.R.S., Emeritus Professor of Liverpool University, which took place last Friday at the age of 86. He was born at Billericay in Essex and in 1876 was Senior Whitworth Scholar. After four years as Professor of Engineering at Bristol University College, he was appointed to the Harrison Chair of Engineering at Liverpool University College in 1885. It is interesting that one of his students at this time was Mr. John Shaw, the well-known foundry metallurgist. He resigned in 1904 and received an appointment as the first Professor of Engineering in the Transvaal Technical Institute, later becoming its principal. He was perhaps best known to the present generation of foundrymen as the brilliantly-successful chairman of the numerous luncheons and dinners held in connection with the Engineering and Shipping Exhibitions at Olympia. Prof. Hele-Shaw was a successful and prolific inventor, his field ranging from clutches, pumps, steering gear and couplings to filtering plant, and even to starched collars.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Melton Metallurgical Laboratories, Limited—Capital, £1,000. Directors: C. T. Walmsley, 9, Spring Vale, Cippenham, Bucks; E. Ross and M. A. Holden.

John Townroe & Sons, Limited, 138, West Street, Sheffield, 1—Capital, £1,500. Chromium, electro and metal platers, etc. Directors: A. P. and J. A. Leonard.

Johnson Bros. (Taps & Dies), Limited, Neville's Factory, Chilwell, Nottingham—Capital, £6,000. Machine-tool makers and general engineers. Directors: A., W., and F. A. Johnson.

Forthcoming Events

FEBRUARY 14.

Keighley Association of Engineers:—Ladies evening: lantern lecture on Bolton Priory and Barden Tower, by H. Moore, at Keighley, at 7.30 p.m.

FEBRUARY 15.

Manchester Association of Engineers:—"Economic Planning of a Modern Store." Paper by J. S. Beaumont, at Manchester, at 7.15 p.m.

Institute of British Foundrymen

FEBRUARY 8.

Lancashire Branch:—"Melting and Casting Problems in the Production of High-Strength and Special-Duty Alloy Iron Castings." Paper by A. E. McRae Smith, in Manchester, at 3 p.m.

Scottish Branch:—"Making Rope Pulleys," Paper by J. F. Webster, in Glasgow, at 3 p.m.

FEBRUARY 11.

Burnley Section:—Ordinary meeting, at Burnley, at 7.30 p.m.

FEBRUARY 15.

Middlesbrough Branch:—"Application of Lifting Magnets and Magnetic Separators in Foundries, etc.," Paper by Wm. E. Box, at Middlesbrough, at 3 p.m.

A Refractories Industry within one organisation

The spectacular achievements of industries which use refractories tend to overshadow the remarkable development of refractory materials during recent years. Higher temperatures and increasingly severe operating conditions have long since deposed "rule-of-thumb" methods of manufacture. Research—applied by the refractories industry, by manufacturers (such as General Refractories), and by users—has developed a range of refractories which are, at least, abreast of to-day's metallurgical processes and plant design. Unrivalled supplies of raw materials—the employment in its many works of modern plant and equipment—the services of leading technicians, operating in works bearing names familiar to all users—and supported by a wealth of practical experience—enable General Refractories to operate a complete refractories service inside one organisation. And, influencing all activities, controlling production and future development, is "G.R." Research. In modernly equipped laboratories a team of qualified chemists and engineers build into each "G.R." product that consistently uniform quality which is the basis of low operating costs and long dependable service.

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FIREBRICKS: *Glenboig Special, Glenboig Special Crown, Glenboig, Glenboig Crown, Castlecary, Dykehead, Gem, White Carr, Stour, Hycone, Alumantine, Hysilyn, Adamantine, Llangennech.*
BASIC BRICKS: *Spinella, Saxpyre, Supermag, Diazite, Dolomax.*
ACID-PROOF REFRACTORIES: *Obsidianite, Losol.*

INSULATION: *Amberlite* Bricks, Cement and Concrete.
SILICA BRICKS: *Lowood, Meltham, Allen, Quartex.*
CEMENTS: *Sintex, Durax, Pyrolyte.* PLASTICS: *Durax, Rotaline, Plastic K-N., Glendoline, Ground Ganister.*
SILLIMANITE: Tank Blocks, Bricks and Cements.
SANDS: Moulding, Brick Facing, Silica, Glass.

Raw Material Markets

The pig-iron supply situation may be termed satisfactory, as, although before purchasing licences are granted by the Iron and Steel Control proof must be given that the iron is required for important work, all priority orders are being fulfilled without delay. A certain amount of lost time in the delivery of iron is occasioned through transport hold-ups in some districts, but these have not affected the production of works engaged on Government orders, as these concerns, generally, have small reserve stocks which have proved ample pending the arrival of fresh material. Demand for foundry iron is increasing as conditions in the light-castings trade improve, while the needs of the heavy engineering establishments are as great as ever.

Pig-Iron

MIDDLESBROUGH — A steady influx of foundry iron from the Midlands is reported by consuming works in this area, necessitated by the almost complete absence of production of Cleveland iron, and, apart from the longer wait for deliveries occasioned by the greater distances to be covered from the makers' works, users are not inconvenienced. Light-castings foundries are working much better time than they were a comparatively short period ago, and have quite a substantial volume of work for various Government departments. Nevertheless, further business is solicited by most concerns. Heavy foundries, on the other hand, are kept in continuous operation, official contracts being placed freely. These works use both high- and low-phosphorus irons and consumption tends to expand. Careful scrutiny is made of all applications for hematite, supplies of which are on the short side. The Control have a supply of American hematite on hand, but this is naturally distributed with caution and only to high-priority users. Strenuous efforts are being made to maintain hematite output at capacity levels. In addition to users in the Middlesbrough area, consumers in the Sheffield and Midlands are being supplied from works here.

LANCASHIRE — Derbyshire and Northants makers of foundry iron are receiving orders for considerable tonnages to meet the heavy requirements of Lancashire consumers. Speciality engineers and heavy founders are fully occupied with commitments for Government departments, and order-books will remain filled so long as the need for the maximum war effort exists. Jobbing foundries are mostly well placed, but some concerns cannot book far forward. This is true also, and to a greater extent, of the light-castings industry, which continues to require much more business, despite the allotment of a certain amount of Government work.

MIDLANDS—High-phosphorus iron for the light-castings makers is in ample supply, and all requirements can be met without delay. Consumption is still rising, as additional contracts directly associated with the war effort are being given to manufacturers who are in a position to cope with them; in many cases this has entailed changed methods and a number of works are now turning out products quite different from their usual range. Northamptonshire and Derbyshire furnaces are supplying the needs of Midland light foundries, and deliveries are quite satisfactory. Hematite and low-phosphorus iron are not in such free supply as high-phosphorus material, and the Control are having to scrutinise very carefully all applications for fresh tonnages, so as to ensure that available quantities are directed to consumers engaged on work of national importance. Imported material is being used where necessary.

SCOTLAND—An insistent call for supplies of foundry iron is being made, but priority users are receiving adequate tonnages to enable them to maintain maximum outputs. Other consumers are at times kept waiting short periods for deliveries. While heavy engineers are fully employed, many of the light-castings foundries are hoping for further orders, although their position is steadily improving. Hematite and basic for the steel plants are in full request.

Coke

The foundry coke position is eminently satisfactory; most of the larger consumers have stocks in hand, and so do not feel the pinch when deliveries fall behind schedule, as they have done at times owing to transport delays. Ovens are able to meet all demands promptly and are willing to book ahead. The Control price of Durham best foundry coke is 61s. 6d. per ton, delivered Birmingham and Black Country stations, but this quotation is subject to revision at any time, so that all forward transactions are negotiated on the basis of the price paid being that in operation at the time of delivery. This system is working quite smoothly, although both buyers and sellers would prefer to know in advance the actual prices to be paid.

Steel

Practically all classes of steel are finding their way into war contracts, and pressure for deliveries is insistent. Home outputs are at peak levels, but it is necessary to make use of imported material, so great is the rate of consumption. Fortunately, we are able to acquire large quantities of American steel, and the Control authorities are purchasing as much United States metal as is required to meet the requirements of priority orders. Special steels are being used on an ever-increasing scale, consumption in the munitions and aircraft industries being very large.

Scrap

It was stated in the House of Commons on Thursday last that the scheme for the voluntary surrender of non-essential iron railings for scrap had been extended beyond the test areas referred to by Sir Andrew Duncan on November 20 last, and would be further extended in the near future. Some thousands of tons of railings had been collected since the end of November. In addition to railings, many other grades of scrap are being regularly brought in for sorting and classification prior to being despatched to consuming points, and the supply position, on the whole, is satisfactory.

Metals

Every effort is being made to conserve our supply of copper, but there is no stringency in allocations to consumers engaged on Government work connected with the war effort—rather is the present policy one of caution and regard for the future. Scrap copper is being utilised where practicable. It is now known that the American Metals Reserve Company will sell copper included in the first purchase of 100,000 tons to domestic fabricators engaged on Government contracts at the domestic quotation of 12 cents per lb.; the metal was bought at 10 cents per lb., f.a.s. New York. The company will only sell the metal to buyers on the condition that they can prove that they have been unable to acquire the tonnage they need from their usual sources of supply at current market prices. As reported in our last issue, the U.S. Government has decided to purchase a further 100,000 tons of Latin-American copper, and it is expected that this metal, too, will be disposed of in a similar way, which is gratifying, as it indicates that the normal marketing channels of domestic production are being interfered with as little as possible.

When the establishment of a tin smelting industry in the United States was first canvassed, it was generally assumed that any smelters brought into operation would be dismantled after the emergency had passed. Lately, however, there appears to be increasing support in the United States for the view that the industry should be continued after the war. The experience of the smelter operations in America during the war of 1914-18 will not be easily overlooked, however, and it would seem that these are early days to consider post-war tin smelting on the other side of the Atlantic. On this subject the "American Metal Market," in a recent issue, stated that the process should be one that contemplated continued operation in peacetime and not simply as an expedient that covered a so-called emergency. Was it not high time that the American Government took a stand that tin be smelted in the States as long as tin ores could be obtained, and by methods which would discount any advantage abroad due to the low cost of labour, through the use of highly mechanised methods which might be employed in America, queried the paper.

The total visible supply of tin on January 31 was 38,584 tons, against 39,066 tons on December 31, according to Mr. W. H. Gartsen (Henry Rogers, Sons & Company). The carry-over in the Straits Settlements was 3,333 (3,472) tons, while the carry-over at principal European smelters was 2,868 (2,248) tons. Deliveries of tin to the United States in January were at the record level of 12,760 tons, the previous highest figure being 12,505 tons in November last.

The current issue of the organ of the Tin Producers' Association, "Tin," states that "there appears to be reason for believing that the hopes of the tin-mining industry that the 100 per cent. Excess Profits Tax may be reduced to something more equitable are within sight of fulfilment. There can be little doubt that any such revisions will include a reduction in the basic rate of the tax. Such reduction may be accompanied either by a reintroduction of the Limitation of Dividends Bill, or by the stipulation that any profits retained by industry as a result of the amendment of the tax must be invested for the duration of the war in Government securities. Against such reservations there will be no complaint," add the journal. "Grateful as the tin-mining industry would be for such a concession, however, it will not be considered ungracious if it considers it, by itself, insufficient. A tax which places a provincial omnibus undertaking in the same risk-bearing category as an armaments works on the East Coast, or classes a short-life tin mine with a Rhodesian copper mine or a United Kingdom coal mine is fundamentally unsound, and the unsoundness cannot be rectified by a mere reduction in the basic rate."

Tin prices on the London Metal Exchange during the past week have been as follow:—

Cash—Thursday, £256 to £256 10s.; Friday, £256 to £256 10s.; Monday, £256 10s. to £257; Tuesday, £256 5s. to £256 10s.; Wednesday, £256 to £256 5s.

Three Months—Thursday, £257 5s. to £257 10s.; Friday, £257 15s. to £258; Monday, £258 to £258 5s.; Tuesday, £257 10s. to £257 15s.; Wednesday, £257 15s. to £258.

Production of spelter at sources open to the Ministry of Supply continues to expand, but consumption, also, tends to increase, so that the existing arrangements for distribution are unlikely to be relaxed. As far as lead is concerned, supplies are ample. The building trade is largely quiet, but there is some activity in this industry on military account.

Steel Products Acquired without a Licence

At Rochdale Borough Police Court, on January 24, John James Smithies, Limited, of Rochdale, were fined £40 on each of three charges for having acquired quantities of re-rolled steel products without the authority of a licence issued by the Ministry of Supply, and they were also directed to pay costs amounting to £20. The defendants, who were represented by Mr. Percy Butlin, entered a plea of guilty.

Mr. Cobbett, on behalf of the Director of Public Prosecutions, said that the charges related to the purchasing of re-rolled steel during February, March and April last. According to his figures, the total amount obtained was 107 tons 1 cwt., whereas the defendants had applied for a licence and were granted one for 30 tons. Having obtained this quantity it was their duty to apply for another licence.

Mr. Butlin stressed that there had been no flouting of the objects of the regulations, which were to ensure that steel was distributed in the best national interest. The defendants had committed merely a technical breach by not sending their return forms in time to get a licence for steel. The steel which they did obtain had gone to people engaged on work of national importance.